THE PROBABLE DISTRIBUTION OF WHALES AS SONAR TARGETS IN THE NORTH PACIFIC OCEAN BY ANALYSIS OF WHALING DATA

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THESIS

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by

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ABSTRACT

False Sonar targets present a serious unpredicted problem to U.S. Navy ASW units. It is believed that planning and operations could be enhanced by a forecasting capability for whale distribution. As a possible solution to this problem, a modified form of the "Transect Method of population estimation" is applied to whaling data to calculate probable numbers of false targets per 1000 nautical miles of steaming with a 1000 yard sonar range. Japanese and Russian whale fishery data are analyzed by the "q" and Expected Catch methods of population dynamics to obtain two independent estimates of the populations of fin, sei and sperm whales. The mean of the two estimates is applied to the equation along with a term for assumed ideal sonar conditions. The data is calculated by ten degree square of latitude and longitude, north of 30°N, and presented on Fleet Numerical Weather Central polar stereographic charts for the months April through December. The number of false targets attributable to fin, sei and sperm whales alone range from 1 to 63 south of the Aleutian Islands and 1 to 30 off Honshu, Japan.

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I. INTRODUCTION

To the ASW unit, one of the most serious problems encountered is the vast amount of time wasted prosecuting spurious or false sonar contacts. Detection of a contact requires the detachment of a ship or ships from the task group to investigate the threat; thereby diminishing the overall capability of the screen in protecting the main body. Of the many sources of false sonar contacts, the most troublesome and most difficult to distinguish from actual submarine contacts are whales. It is, therefore, imperative that methods be developed to reliably predict areas of high whale density which will serve to alert sonar operators.

Since the resumption of the Japanese whale fishery following World War II, a great deal of interest has been generated in determining the areas of whale abundance and seasonal fluctuations in whaling grounds, resulting in a research effort in the sub-arctic North Pacific Ocean. To date, research has proceeded in three major areas of interest: geographical distribution of the major whale species, investigation of biological and behavioral characteristics, and examination of the oceanographic conditions of the whaling grounds. Each of the three is essential in attempting to determine the factors which control whale migration and defining favorable whaling regions.

The first major work on whale migrations (Kellog 1929) described the primary paths of migration for blue (Balaenoptera musculus), sei (B. borealis) and fin (B. physalus) whales in the Pacific and Atlantic Oceans, in general terms, based on all sighting and catch information available at that time. Whaling grounds developed over the years and

were illustrated by Townsend (1935) by plotting catches according to logbook records of American whaling ships for a period of one hundred fifty nine years (1761-1920). Other researchers have concentrated on more limited areas of the North Pacific in response to the whaling interests of their own country's territorial waters (Omura and Nemoto 1955; Clarke 1957; Sleptsov 1961; Tarasevich 1965, 1970; Nishiwaki and Kasuya 1970; Kasuya 1971). General distribution charts of cetaceans in the North Pacific were developed by Nishiwaki (1967). Experimental investigations were also conducted (and continue) by means of whale marking (Shevill and Watkins 1966; Ivashin and Rovnin 1966).

Feeding habits and food preferences were investigated by observation and investigation of stomach contents (Nishimoto, Tozawa and Kawakami 1952; Nemoto 1957; Nemoto 1959; Nemoto 1962; Nemoto and Kasu 1965) which were correlated with migration cycles of baleen whales (Nemoto 1959). Schooling behavior in the feeding areas was examined (Nemoto 1964) and compared with patterns of sexual segregation (Ohsumi 1966).

Consideration of biological parameters has mainly been confined to development of reliable methods of age determination by ear-plug lamination count (Nishiwaki 1952; Nishiwaki and Masaharu 1952; Nishiwaki et al 1957; Nishiwaki 1957; Nishiwaki 1958; Ichihara 1969, Ichihara 1963, Ichihara 1964; Ichihara 1966) and dentine layer count in the case of sperm whales (Nishiwaki 1958; Ohsumi 1963; Gambell and Grzegorzewska 1967). Complimentary studies have focused attention on the determination of average body proportions and growth rates (Mathews 1938; Omura 1950; Nishiwaki and Ohe 1951; Nishiwaki and Hibiya 1951; Nishiwaki et al 1952; Ohno 1952; Omura and Fujino 1954; Nishiwaki 1954; Fujino 1954; Omura and Nemoto 1955; Fujino 1955; Nishiwaki 1956; Ohsumi 1958; Nasu and Masaki 1970).

Uda (1954), Uda and Dairokuno (1957), Uda and Suzuki (1958), Nasu (1960), Uda (1962), Nasu (1963), Nasu (1966) have conducted oceanographic studies with the objective of determining the exact physical parameters which define favorable whaling grounds and correlating these with meterological conditions (Uda 1956) e.g. fluctuations in sea surface temperature, salinity and nutrients.

Leapley and Levenson (1969) have published the only study to date evaluating the false target threat. This study plots contours of expected numbers of false targets due to whales in the eastern North Atlantic ocean, based on sighting records obtained over a five year period.

The objective of this thesis is to take advantage of these studies to provide information on the number of whales which an ASW ship may expect to encounter as false sonar contacts during operations in the North Pacific Ocean. Instrumental to this objective is the application of a modified form of the "transect method of population estimation" to whale fishery data reported by Japanese and Russian whaling companies north of 30°N. This information may be applied by fleet units operating in the North Pacific and by commanders planning operations in these areas.

II. METHODS

A recognized and frequently applied method of population estimation for game, birds, and other animals, based on sighting observations, is the Transect Method. This method uses the number of animals sighted in a known distance, combined with the distance from the track of the sightings to plot contours of relative abundance.

Mackintosh and Brown (1956) developed a modified version of this method for use in determining the fin whale population of the Antarctic whaling grounds. It is based on the number of sightings made while steaming through a representative distance of an ocean area when no estimates are made of the distance of the whales from the track of the sighting vessel. This method may be expressed:

$$N\ (\text{whales}) = \frac{A(\text{nmi}^2)}{L(\text{nmi})D(\text{nmi})} \times \frac{n(\text{whales})}{P}$$

where:

N = calculated total population of area A

A = area of ocean considered in square nautical miles, nmi^2

L = distance steamed through the area in nautical miles, nmi

D = lookout visibility in nautical miles, nmi

n = number of whales sighted in distance L

p = an empirically determined probability factor based upon weather conditions, sea state and visibility.

Consideration of the behavioral characteristics of whales in feeding and migration suggested the applicability of this method to evaluation of false target threats. Nasu (1966) reports that feeding whales are

commonly found at depths less than fifty meters. The exception to this would be sperm whales, which occasionally dive to great depths to feed on giant squid (Heezen 1975; Okutani and Nemoto 1964). However, in the North Pacific, they most frequently feed on schooling fish and therefore can also be considered to be mainly distributed in the upper fifty meters. Migration also takes place on or near the surface. Thus, although a sonar ensonifies a volume of water, in the case of false targets attributable to whales we may consider this ensonified region as an area. It is then readily apparent that the searching sonar beam is analogous to the eye of the lookout on a surface ship and this method may be applied to the evaluation of false targets. In this concept, the sonar range is analogous to the lookout's visibility.

Assuming ideal sonar conditions:

$$n \text{ (number of false targets)} = P \, \frac{L(\text{nm}) \times D(\text{nm}) \times N \text{ (whales)}}{A \text{ (nm}^2)}$$

where:

n = expected number of false targets

L = distance steamed in nautical miles

D = two times the sonar range in nautical miles

A = area of the oceanic region

N = calculated population of area A

P = probability factor determined by sonar conditions.

These quantities are illustrated in Fig. 1.

For the purposes of this study, ideal sonar conditions were assumed and, therefore, P was taken to have a value of one; indicating that if a whale is present it will be detected. Under actual operating conditions this criterium is rarely met since the value will seldom be equal

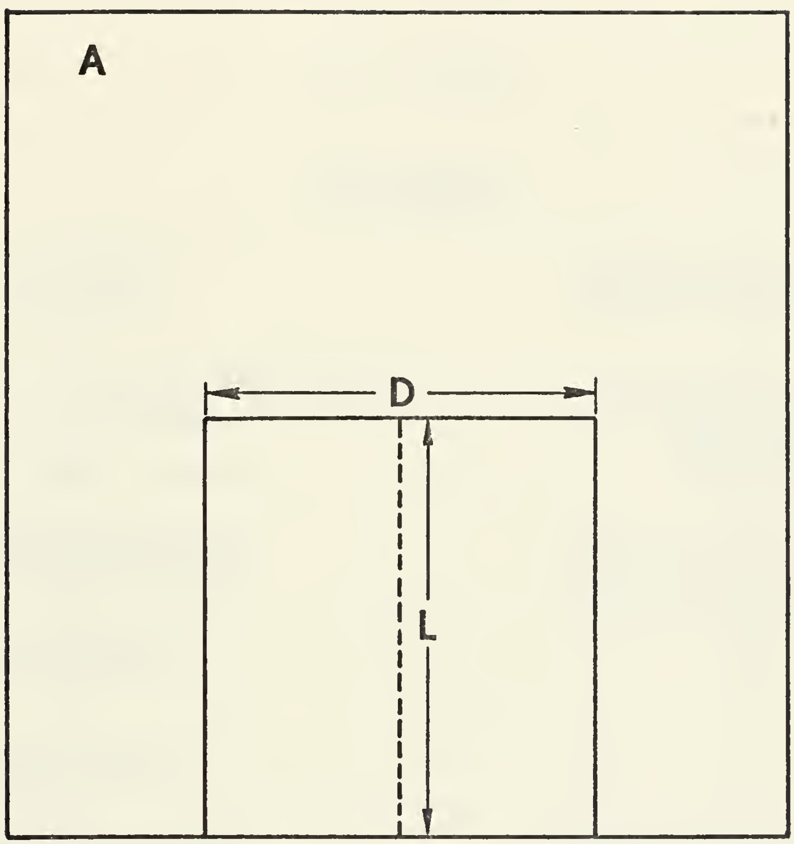
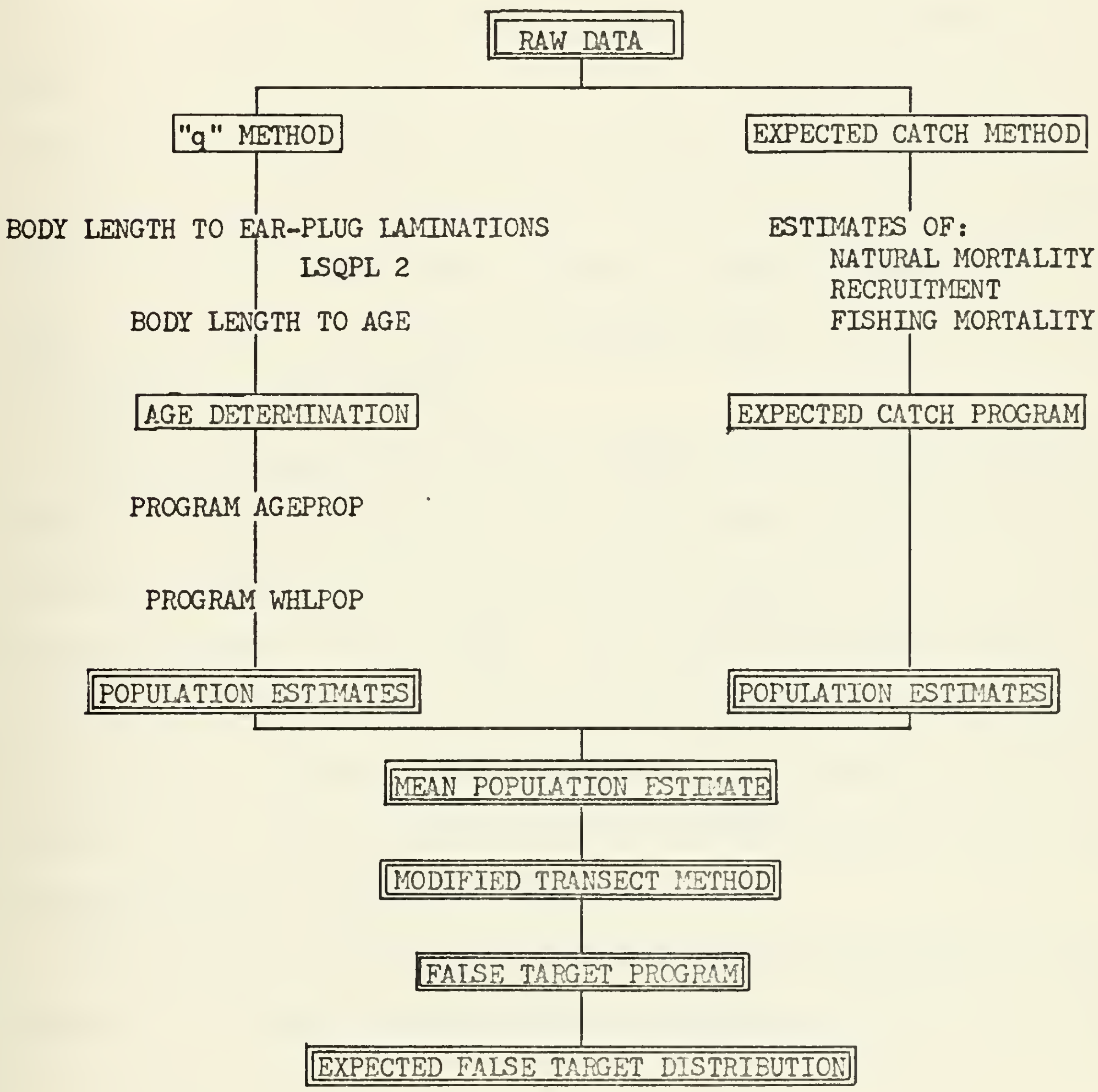


Figure 1. Illustration of Terms Used in Modified Transect Equation: A = ocean area, D = sonar range, L = distance steamed through area A.

to one, but will be determined by the factors affecting the sonar range in the particular area of operation.

In order to make clearer the techniques used and the sequence of operations, the analysis scheme followed in this thesis is presented diagramatically in the following flow diagram.

FLOW DIAGRAM



The raw data is taken from Russian and Japanese North Pacific fin (Balaenoptera physalus), sei (B. borealis) and sperm (Physeter catadon) whale fishery catch results for the years 1966 to 1970. The total catch was listed by ten degree square, effort (in catcher days) and length frequency distribution. Two independent methods of population dynamics, the "q" method and the expected catch method, ECM, were utilized to estimate populations in selected geographical subdivisions shown in Fig. 2. For the purposes of this study, Brydes whales were included with sei whales since they are distinct from sei whales only by the presence of ventral grooves and otherwise have the same physical characteristics.

The age composition of the catch was determined and the data analyzed by the "q" method (Allen 1966), utilizing a computer program written to apply this method. This program, designated WHLPOP (Appendix B), yielded the initial population estimate.

The second independent estimate of population size was calculated by means of the "Expected Catch" method (Allen 1966) using values for natural mortality and recruitment[1] obtained from the reports of the International Whaling Commission (IWC 1966-1970). This method was applied using a program provided by Dr. K. R. Allen, Fisheries Research Board of Canada, Biology Station, Nanaimo, British Columbia. The program was modified to conform to the IBM 360 located at the W.R. Church Computer Center, Naval Postgraduate School, Monterey, California.

In accordance with procedures followed by the International Whaling Commission (IWC 1968) the mean of the two population estimates was taken

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[1] The addition of whales to the hunted portion of the population by growth from younger ages.

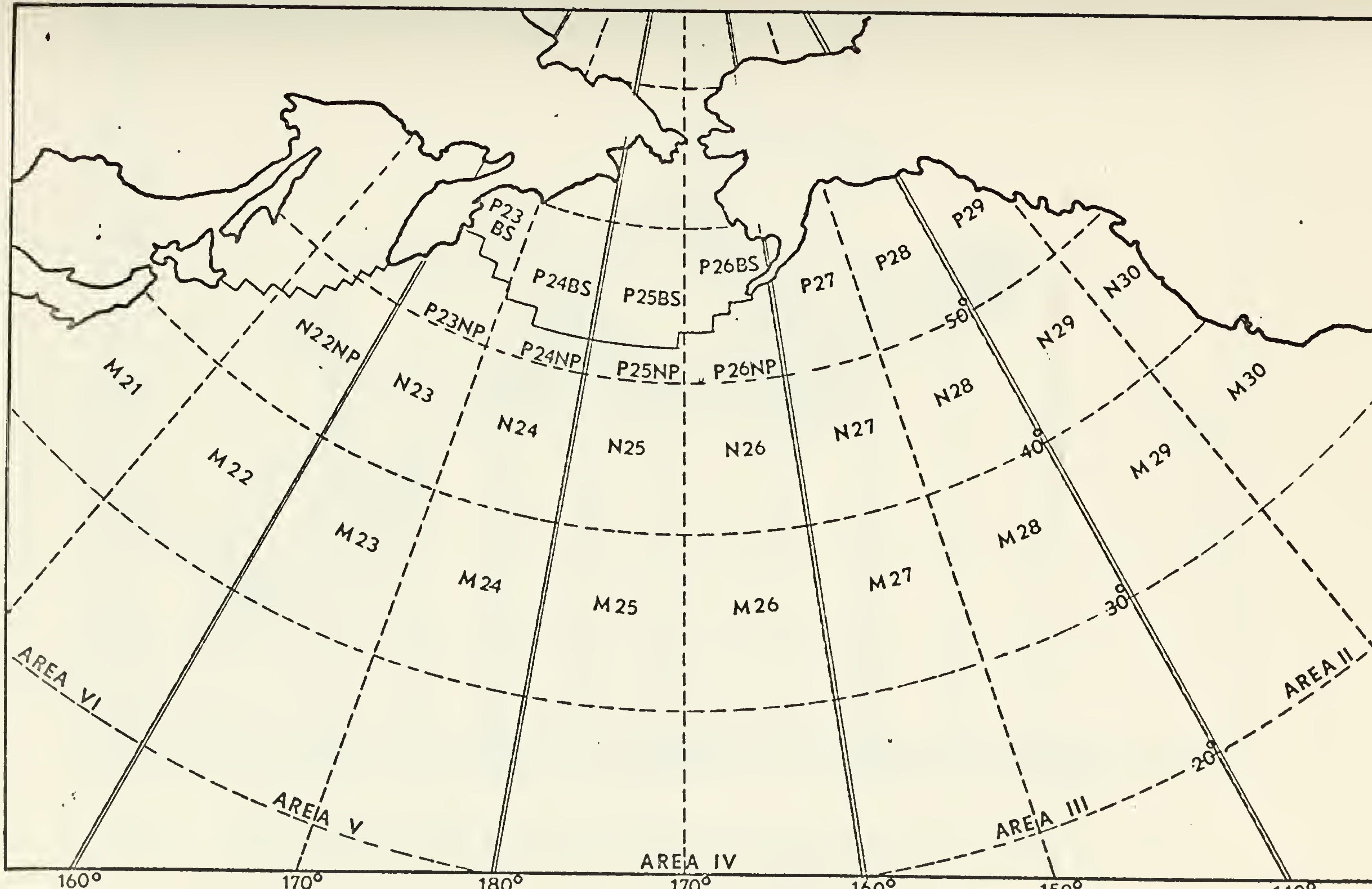

Figure 2. Statistical Areas: Subdivisions of North Pacific Ocean for Reporting Whaling Statistics According to the International Whaling Commission.

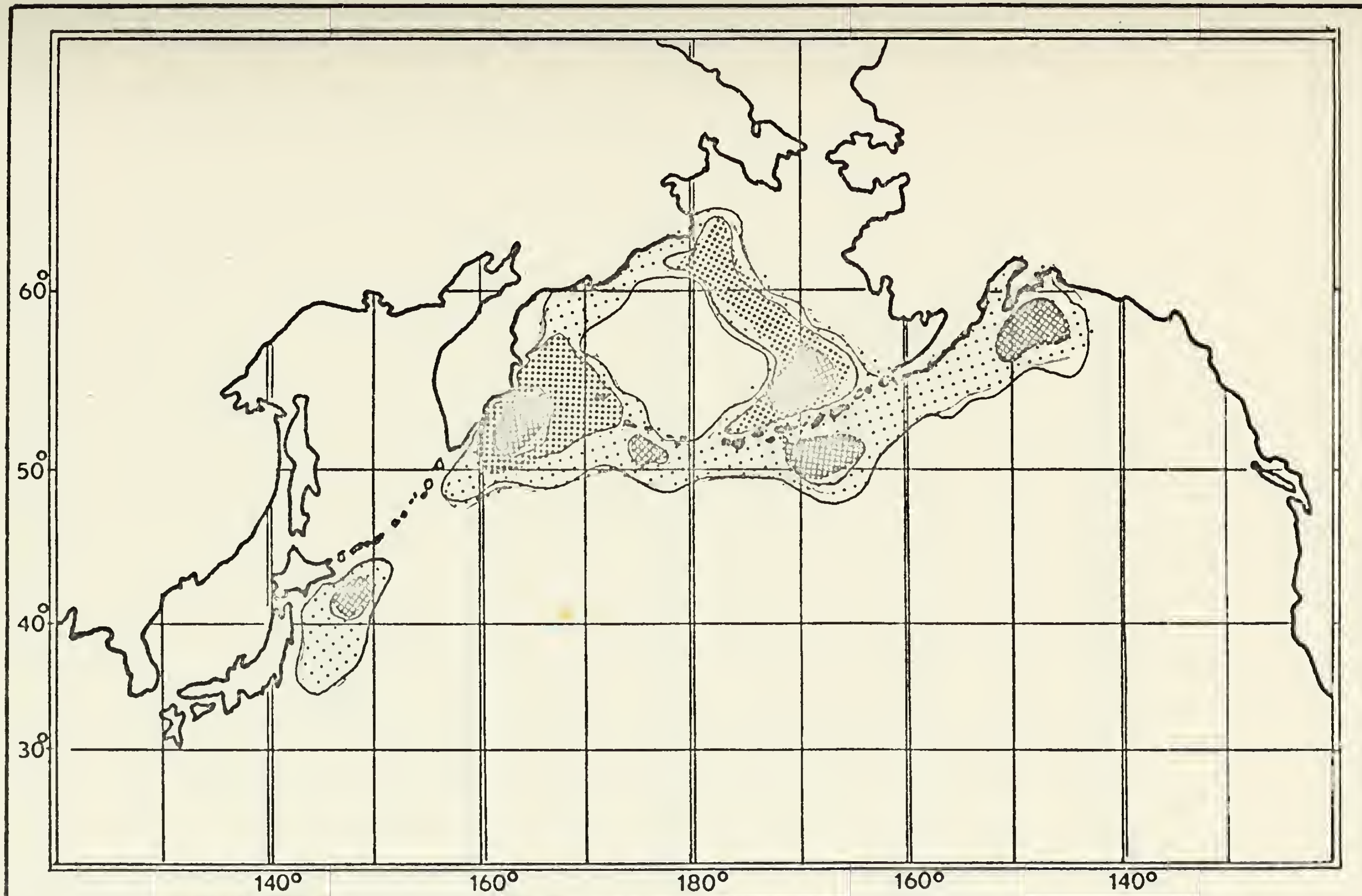

Figure 3. Distribution of Fin Whales from Japanese Historical Catch Records 1945-1962 (after Nishiwaki 1967) <10, 10-50, >50.

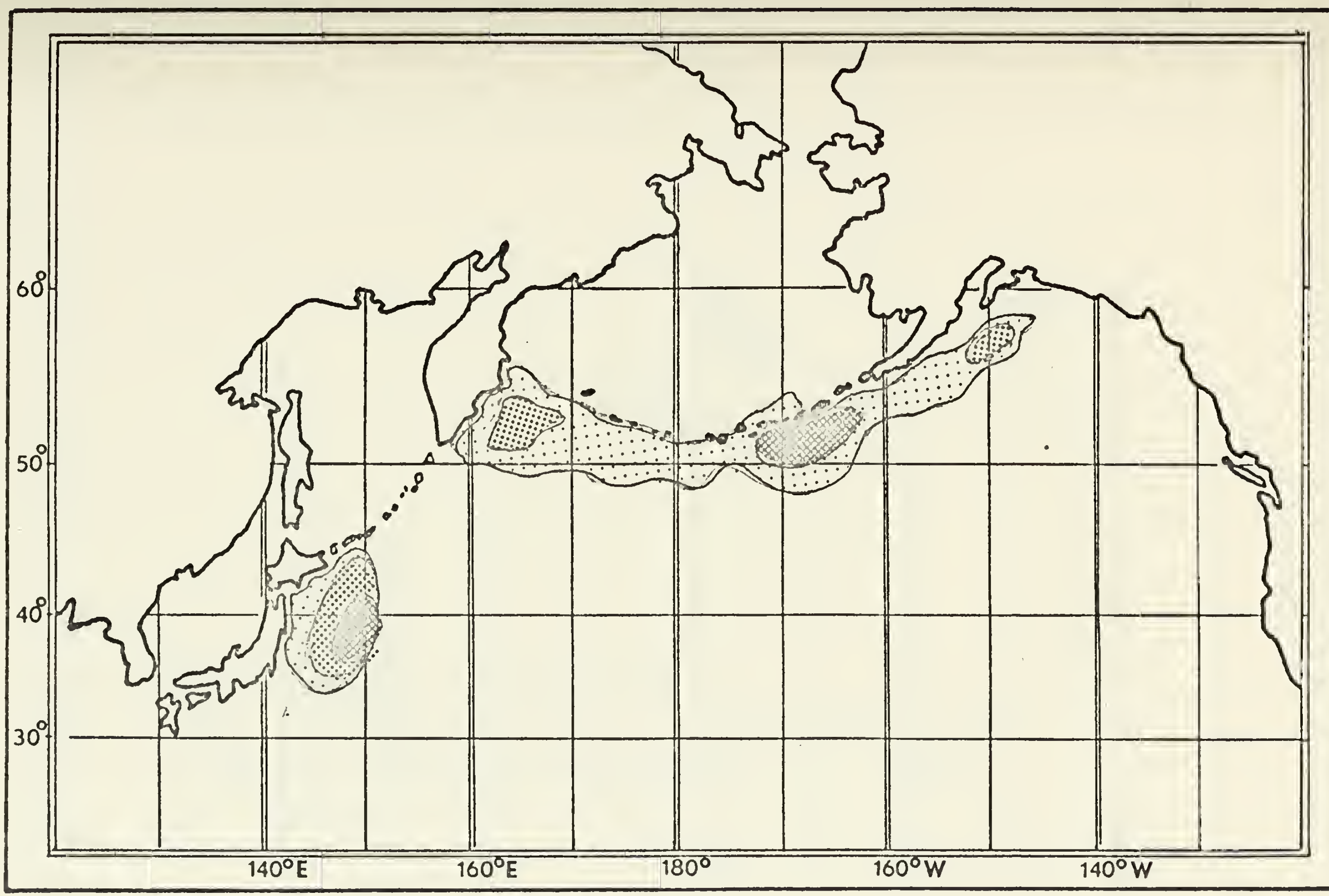

Figure 4. Distribution of Sei Whales from Japanese Historical Catch Records 1945-1962 (after Nishiwaki 1967) ::: <10, ░ 10-50, ▓ >50.

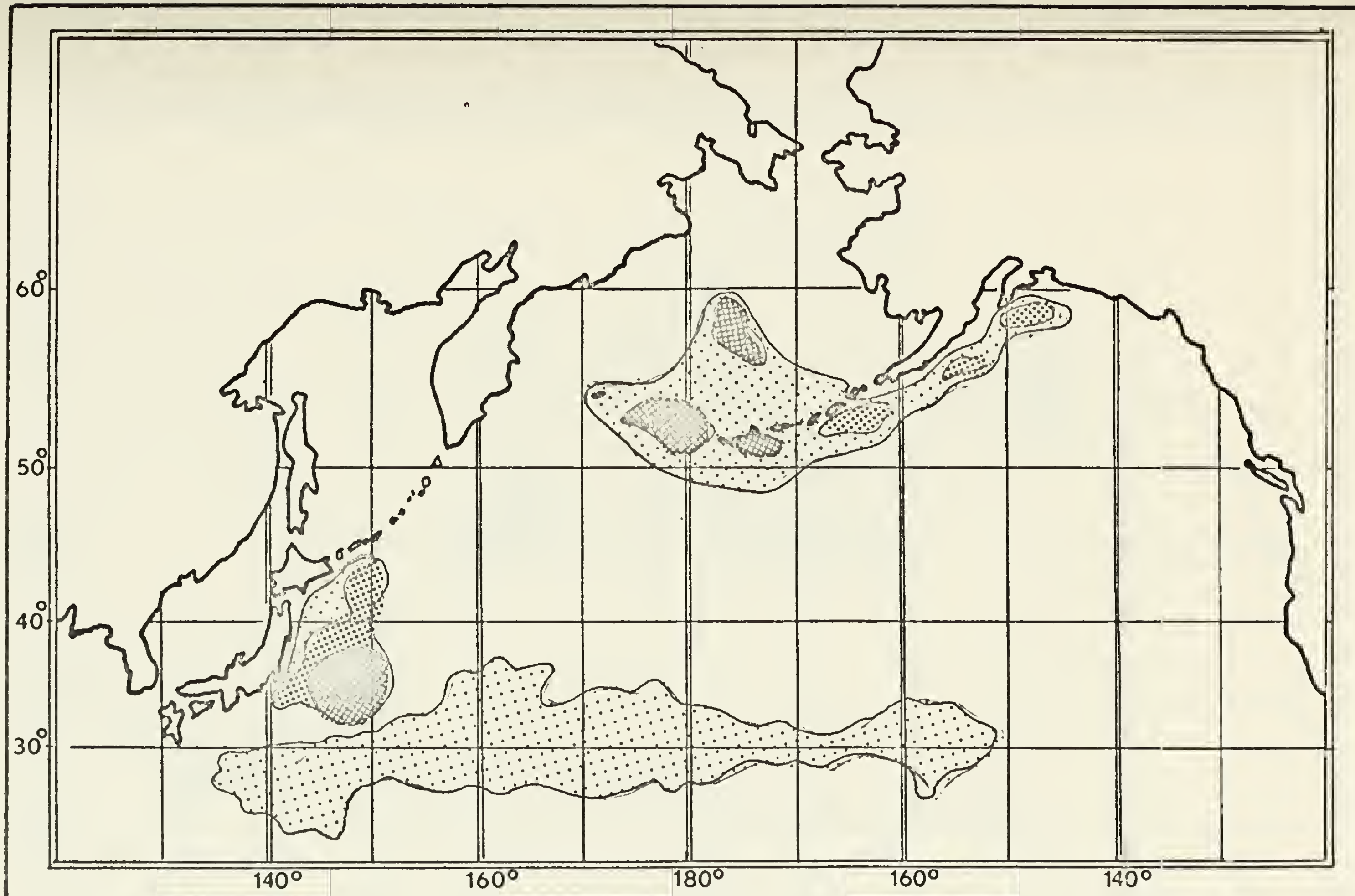

Figure 5. Distribution of Sperm Whales from Japanese Historical Catch Records 1945-1962, and American Catch Records 1761-1920 (after Nishiwaki 1967, Townsend 1935) ::: <10, 10-50, >50.

Sperm

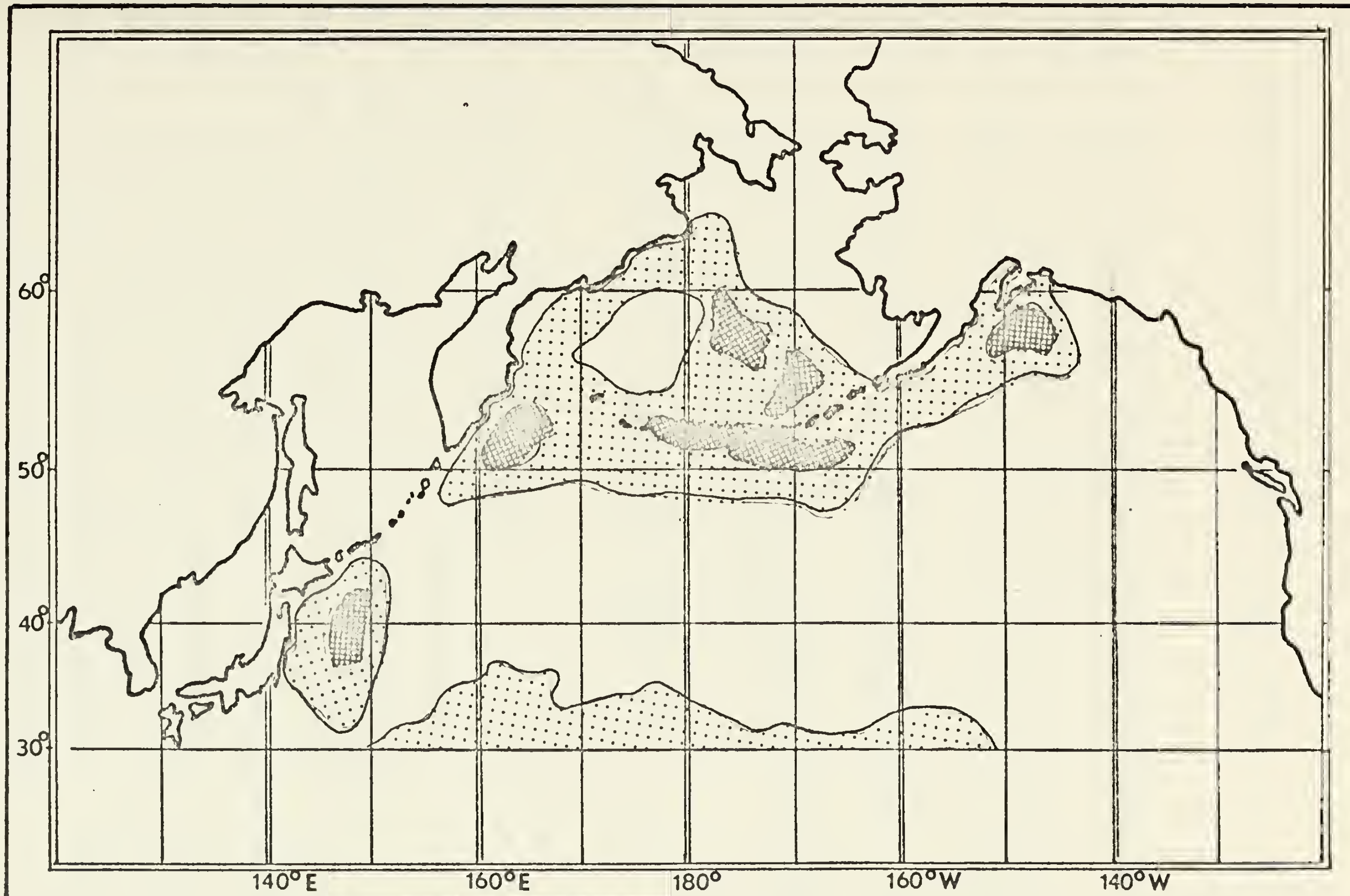

Figure 6. Composite Distribution of Fin, Sei and Sperm Whales in the North Pacific Ocean from Japanese Historical Catch Records 1945-1962 (Nishiwaki 1967) and American Catch Records 1761-1920 (Townsend 1935) ∴∴ Areas of General Distribution ▩ Areas of Higher Density.

and the average expected number of whales in each ten degree square, for the period 1966-1970, was calculated by means of proportions as expressed in equation (1).

$$\text{Number of whales in square } (N_s) = \frac{C_s}{C_A} \times N_i \qquad (1)$$

where:

N_i = estimated mean whale population in the selected area by "q" and ECM for the five year period 1966 to 1970.

C_s = average total catch in the ten degree square over the five years.

C_A = average total catch in the selected area 1966-1970.

Similarly, the average number of whales present per month in each ten degree square was calculated by equation (2):

$$\text{Number of whales per month } (N_m) = \frac{C_m}{C_s} \times N_s \qquad (2)$$

where:

C_m = average total catch in the month

C_s = average total catch in the ten degree square

N_s = population of the square calculated in equation (1).

Historical records of Japanese whale fishing (Figures 3-5) for the years 1945 to 1962 (Nishiwaki, 1966, 1967) were combined with studies of migratory cycles and distribution by Nishiwaki and Kasuya (1970) and historical catches (Townsend 1935). This was done to determine areas of distribution for fin, sei and sperm whales. From these, a composite area chart was developed, Figure 6, showing where whales could be encountered as false targets. In areas where no historical geographical data was available, i.e. Russian fisheries in squares M28-30 and N27-30 (Figure 2),

a uniform distribution of the calculated average whale population per month was assumed over the entire ten degree square. The number of whales per one thousand miles steaming with a 1000 yard sonar range was then calculated using the modified form of the Transect Method of population estimation described earlier. This was then plotted on Fleet Numerical Weather Central polar sterographic charts (Figures 24-32).

A. THE "q" METHOD

Whaling in the North Pacific produces data which is highly variable, particularly in the measure of catch per unit effort.[2] This variation is produced primarily as a result of the smaller effort employed, as compared to the Antarctic fishery, and the exploratory nature of the fishing effort to develop new whaling grounds. Methods utilized in population estimation must therefore be designed to normalize the data in order to give reliable estimates even in the presence of this high variability. One such method is the "q" method.

The basic assumption of the "q" method is that the ratio between the instantaneous fishing mortality rate, F, and the total fishing effort, X, is constant, i.e.

$$q = \frac{\text{instantaneous fishing mortality}}{\text{fishing effort}} = \text{constant} \tag{3}$$

Using the pooled data for as many years as possible, an estimate of "q" is obtained and the population computed by dividing the catch per unit effort, C/E, by q. In this method a base year is selected in which it is assumed that the population structure is determined by natural mortality and that recruitment has been constant from year to year.

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[2] The total catch of whales, in numbers, divided by the effort required to produce the catch (equation 4).

The essential features of this method are:

(1) A single year group[3] is followed throughout to avoid the effects of recruitment.

(2) The relative abundance of the selected year or age group is compared in each succeeding year with the base year[4], where it is assumed that the age structure is unaffected by exploitation. Thus, the population structure by ages is determined by natural effects with no deaths due to fishing.

(3) Estimates of the total fishing mortality[5], for all age groups, and the instantaneous fishing mortality of the specified age group are obtained for increasing periods of years. Thus the effects of data fluctuations due to seasonal variation are minimized. These estimates are then divided by the total effort over the same periods to obtain a mean estimate of "q," table II.

(4) The effort expended in the whale fishery by different size catchers with varying endurance is standardized by multiplying catcher days by vessel tonnage and dividing by one thousand, i.e.

$$\text{Effort} = \frac{\text{Catcher days work X catcher tonnage}}{1000} \tag{4}$$

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[3] The portion of the population consisting of all whales of a specified age and older.

[4] An arbitrarily selected year in which the population is assumed to be affected by natural effects only with no deaths attributable to the effects of man. This year is used as a reference.

[5] The ratio of the number of deaths to the total number of whales in the population, summed over the year.

TABLE II

EXAMPLE OF "q" METHOD

Fin Whales Area V

Year	Catch	Effort	C/E	$0_1/0_t$	X	F	$\frac{0_t}{\bar{q}}$
1966	1298	543	2.3904	1.0000	0	0.0000	4006
1967	772	1082	0.7135	3.3503	813	1.4202	1196
1968	1172	1167	1.0043	2.3802	1937	1.5073	1683
1969	1021	1235	0.8267	2.8915	3138	1.9719	1386
1970	667	909	0.7338	3.2577	4210	1.1254	1230
					10098	6.0248	

$$\bar{q} = \frac{6.0248}{10098} = 0.000597$$

C/E = Catch Per Unit Effort.

$0_1/0_t$ = Ratio of Catch Per Unit Effort in Year 1 to Catch Per Unit Effort in Year t.

X = Total Effort.

F = Fishing Mortality.

Pop $\frac{0_t}{\bar{q}}$ = Population Calculated by Dividing Catch Per Effort in Year t by Mean Value of q.

The basic equation is:

$$F_t = \ln \left[\frac{Q_{1,r}}{Q_{t,r+1-1}} \times \frac{Q_{0,r+t-1}}{Q_{0,r}} \times \frac{\phi_1}{\phi_t} \right] \tag{5}$$

where:

F_t = total instantaneous fishing mortality from year 1 to year t.

$Q_{1,r}$ = proportion of the catch in year 1 of whales of age r (the first fully recruited age group) and older.

$Q_{t,r+t-1}$ = proportion of the catch in year t of this same year group (i.e. if in the base year six year old whales are examined then two years later the proportion of whales eight years and older must be considered.

$Q_{0,r+t-1}$ = proportion from the catch of the previously unexploited stock of the same age groups.

$Q_{0,r}$ = proportion in the catch from the previously unexploited stock of whales of age r and older.

ϕ_1 = catch per unit effort in year 1.

ϕ_t = catch per unit effort in year t.

These quantities are illustrated in table I.

Since the estimate of F obtained in this method refers to the decrease from the average population in one season to the average level in a later year, the effort X[6] may be written by means of integrating by the Trapazoid Rule:

$$X_t = \frac{1}{2} \left[X_1 + 2X_2 + \ldots + 2X_{t-1} + X_t \right] \tag{6}$$

[6] The total of the effort, E, expended from mid-season in one year to mid-season in the next.

TABLE I

ILLUSTRATION*OF QUANTITIES USED IN "q" METHOD

Cumulative Proportions in Catch of Whales
Age (r) and Older (Russian Area V)

Age Group	Base Year	Year 1	Year 2	Year 3	Year 4
	1966 5	1967 5	1968 5	1969 5	1970 5
0	1.0000	1.0000	1.0000	1.0000	1.0000
1	.9984	1.0000	1.0000	1.0000	.9960
2	.9892	.9991	.9987	.9969	.9799
3	.8768	.9808	.8876	.8220	.8336
4	.8227	.8926	.8309	.7604	.7568
5	.7438	.8043	.7238	.6581	.6468
6	.6208 $Q_{o,r}$	.6810 $Q_{1,r}$	.5712	.5260	.5228
7	.4672 $Q_{o,r+t-1}$	.5024	.3985 $Q_{t,r+t-1}$	.3591	.3527
8	.3776	.4125	.3003	.2737	.2692
9	.2880	.3230	.2021	.1888	.1862
10	.2105	.2734	.1414	.1287	.1359
11	.1337	.2242	.0812	.0686	.0861

*Total set of data are in appendix.

*Output from Computer Program AGEPROP in Proportion of Each Age Group in the Total Catch Converted to Cumulative Distribution for Purposes of Illustration.

The error due to random effects on the fishery may be minimized by extending the estimate of "q" from the base year to successive years and taking the mean as the value for the area, Table II.

Thus:

$$\bar{q} = \frac{\overset{T}{\Sigma} \quad \Sigma F_t}{\overset{T}{\Sigma} \quad \Sigma X_t} \qquad (7)$$

where T is the total number of years in the series.

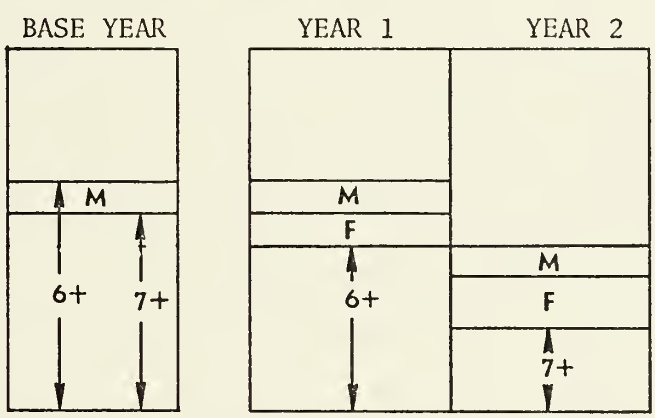
An estimate of the mid-season recruited population is then given by:

$$N_t = \frac{\Phi_t}{q}$$

The "q" method may be explained more simply by the block diagram in Figure 7.

FIGURE 7

Block Diagram Representation of the "q" Method



M = natural mortality

F = fishing mortality

The large rectangles represent the total catches in years 1 and 2. Considering first the catch in year 2, the small rectangle, 7^+, represents the proportion of the catch in year 2 which is seven years old and older.

It can easily be seen that if there were no fishing or natural mortality then the level for the seven year age group would include rectangles F and M. Going back one year, the whales which were seven years old and older in year two are represented by the six year old and older whales in year one. Again we can see the represented effects of natural and fishing mortalities. There are two unknowns, F and M, affecting the age structure of the population. Thus, if an estimate can be made of one, then both in combination, the other can be determined. To accomplish this end, the ratio of the six year olds and older in year one, to the seven year olds and older in year two (term 1 of the basic equation (5)), is compared to the ratio of the seven year olds and older to the six year olds and older, in the base year where only natural mortality has been affecting the age structure of the population (term 2 of the basic equation (5)).

Finally, an adjustment must be made to compensate for the variation in abundance from year to year. It is obvious that if the same amount of effort is expended, the catch per unit effort in a year of greater abundance will be greater than the catch per unit effort in a year of lesser abundance. Therefore, the ratio of the C/E in year one to the C/E in year two, provides a measure of the relative abundance in the two years (term three of the basic equation (5)). Thus by comparing the ratios between successive years with the ratio existing in the base year, an estimate of the natural mortality is obtained and, since this is assumed to be constant, the total fishing mortality may be obtained.

1. The Effects of Migration

As a result of the seasonal migration, in the case of baleen whales, and the more general spreading in the case of sperm whales, there exists a north-south age segregation of the population for a major

portion of the year (Ohsumi 1966, Nishiwaki, 1967, Nishiwaki 1966). Older males penetrate further into the waters of the North Pacific followed by younger males who usually preceed the population front of the migrating main body of whales. There then exists a high probability that an examination of the age structure in any one ten degree square will not be representative of the age structure, but will yield a disproportionately high number of one particular age group. To eliminate the effects of migratory segregation of the population, the age structure and effort are considered for ten degree squares in geographic areas. These areas are composed of twenty degrees of longitude extending from the equator to the pole, Figure 2, thus considering the age structure at all latitudes.

Then, for example, for area III between 140°W - 160°W:

$$X_{III} = X_{M27} + X_{M28} + \dots + X_{P28}$$

and

$$C_{III} = C_{M27} + C_{M28} + \dots + C_{P28}$$

Since the yearly totals of X, C, C/E, etc. are used in the estimation of $\overline{q}$ and these yearly totals are the sum of the individual squares, "q" may be applied to the individual squares to yield monthly estimates of population. This approach, however, requires extensive hand calculations.

B. AGE DETERMINATION

Application of the "q" method requires that the age groups of the catch be analyzed with respect to the length-frequency distribution. The relationship of length to age was determined indirectly from frequency diagrams, Figures 8-19, relating body length to the count of ear-plug laminations.

Figure 8. Male Fin Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Area II

Body length (ft) / Laminations	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
1																		
2																		
3																		
4			2															
5			1		2	2												
6			2															
7			1	2	4		1			1					1			
8			1		1	1	1	1	1									
9					1	2	1	2	2				1					
10					1	2	1	1	1	1								
11				1	3		1			1		1						
12									1	1	1							
13					1	1	1	2	2			2						
14					1		1		1									
15							1	3										
16										3	1							
17							2		1			1						
18										1	1							
19						1		1		1								
20								2		1								
21				1				1	1			1						
22									1									
23								1										
24										1	1							
25					1			1	1	1								
26			1			1					1							
27						1				1		2						
28								1		1				1				
29								1										
30											1							
31									1	1								
32							1		1				1					
33											1		2					
34											1							
35										1		1						
36									1	2				1				
37							1											
38							2											
39																		
40									1									
41										1								
42																		
43									1									
44																		
45										1								

Figure 9. Male Fin Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Area III

Body length (ft) / Laminations	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
1																		
2																		
3			1															
4			1			1												
5			3	2	1	1	2											
6				3	2	2	1											
7			4	1	5	6	3			1								
8			1	3	3	3	1	2		1								
9			7	3	5	5	5	1										
10				1	1	3	1	2	1	1								
11				4	1		3	2	4		1	1						
12			2	1	3	1		5	1	3	1							
13			1	1		2	2	5	2									
14						2	2	1	4	4			1					
15					1			5	4	1	2	1						
16				1		1	1	2	4			1	2					
17					1		2	2	3	4	4	3	1					
18			1		2	1	3	1		4	2	2						
19								1	2	2	1	1				1		
20			1			4	3	3	2		1							
21					1	1	1	3	2	1	1	3	1					
22								2	1			2	2					
23								1	1	3	1	1						
24					1	1	2		4	1	1		1					
25						1		3	2		1	1						
26			1			1	2	2	1	1		1	1					
27						1	1	1	2	3	1							
28						1		2	3			2	1					
29					1			2	2	4	1	1						
30							2	3	1	3	1							
31							2	1	1		2			1				
32					1		1			1	2					1		
33					2		1	2	3	2	1	1	1					
34								1	1	1				1				
35					1			1		1	1							
36									1	1	3	1	1					
37							1	1			1	2		1				
38										1	2	1		2				
39									1	1			1					
40										1		1		1				
41							1	1										
42						1		1				1						
43							1									1		
44											1							
45										1		1						

Figure 10. Male Fin Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Area IV

Body length (ft) / Laminations	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
1																		
2																		
3			2		2		1											
4		1	10	5	3	3	1											
5	1		4	3	3	3		4	5									
6	1		10	6	7	4	9	4	3	1	1							
7			4	5	15	8	8	3	4		1							
8		1	3	7	9	11	8		4	1								
9			1	2	3	7	2	6	4	1		2						
10				1	3	3	7	3	2	2	2							
11			2	3	8	6	5	4	3	2		1						
12			1		2	2	5	5	6	1		1						
13			1	1	1	4	2	4	2	3	2	1						
14					1	4	6	2	3	1	2		1					
15			1			1	1	5		1		1	1					
16					3		2	1		4		1						
17					1	2	2	3	2		2			1				
18					1	3	1	5	3	1	1	3	2	1				
19	1						1	2	5	4					1			
20				1		1	3	2	1	3	1	2	2					
21							1		1	3	3							
22								2	1	3	1							
23						1	2			2	3							
24					1		1	3	4	1	1		1	1				
25					1	1			3	1		1						
26							3	2	1	3	1	1	1					
27				1	1	1					2		2	1	1			
28										4		1	1					
29			1				1	4	2	1	1	2						
30					2	1	1	1		1	1	1		1				
31								3	1	1	1	1		2				
32									1	1	1				1			
33						1	3	3		1	1	3						
34				2			1		1	2	4	3						
35							2		2			2	1	1				
36						1	1				2		2					
37						1			4	2	1							
38								1		5		1				1		
39									1				3				1	
40								1	1	1		1						
41						1		1		1	1		1					
42							1	1	1	1	1	1	1					
43						1	2			1	2							
44				1	1	1				1	1		1					
45									4	1	1	1		1				

Figure 11. Male Fin Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Area V

Body length (ft) / Laminations	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
1																		
2																		
3																		
4																		
5			2	1	4	1	1											
6		1	2	2	1	1	3											
7			6	4	2	2	1	1		1								
8			4	2	2	1	2			1								
9			4	1	3	1	4		2	1								
10			2	1	2	3	1	1										
11			1		2	1	3	1	1	2	3	1			1			
12				1	1	1	1	3	1	3	1		1					
13				1		3	4	1			1		1					
14				1		1		1	2	1								
15						1	2	2			1				1			
16			1		1	1	2	1		1		1	1					
17				1	1	1		2	2				1					
18						1	1	3	3	1	1	1						
19					1	2	2		2	6		2						
20						1	2	2	2	2	3							
21									2	3		1			1			
22						1	2		1	1		3						
23							1		2	1	3	2						
24						1		1	4	3	1		1					
25						1	2	2	4			1						
26						2			1	1		1						
27							1	1			2	1						
28						1			3	1								
29								3			3	2		1				
30							1				2							
31					1	1	1	1	2	1	3							
32									1	2	2		1					
33						1	1	1	4	1	1	1						
34							2	1	3	4	2							
35					1		1		1	3	2		2					
36						1	1	1					1	1				
37							1		2		1			1				
38								1	1		1		1	1				
39										2	1							
40											2			1				
41			1		1	1		2		1	1	1						
42							1	1	1	1	1							
43						1		1			1							
44								2	1		1		1					
45										1		1			1			

Figure 12. Female Fin Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Area II

Body length (ft) / Laminations	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
1																		
2																		
3																		
4					1													
5		1	3		2	1								1				
6		1				1												
7		2	1			1	1	2			1							
8			2			2	1	1										
9				1	1		1	1	1		1	1						
10					1	1	1	1	2	2		1						
11										1				1				
12							1	2		2		1	1		1			
13								1		1								
14								1	2		1			1				
15								1			3	2		1				
16									1		2	1	1					
17								1	1									
18							2		2			1	1					
19												1					1	
20								1				1	1					
21											1	2						
22							1		1		1	1						
23									1	1				1		1		
24										1					1	2		
25									1			2			1			
26									1	1		2	1				1	
27											1	1	2	1				
28													1			1		1
29									1	1	1			1				
30									1	1		3						
31													1					
32								1					1	1	1			
33								1	1			1						
34																		
35													1					
36									1			1						
37											1	1	1			1		
38																1		
39																		
40										1								
41											1			1				
42																		
43									1									
44																		
45																		

Figure 13. Female Fin Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Area III

Body length (ft) / Laminations	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
1																		
2																		
3																		
4		2	3			1	1											
5		2	1	1	2	5												
6		2	4		2	1	1	3	1	1								
7		1	1	2	2	3	1	2	1			1						
8		2	5		2	2	4	4	1			1						
9				1	1	5	5	2		2	1			1				
10		2	2		5	5	1	3	2	1	1	1	1					
11					1		1	2	1	1			1					
12								4	5		1	1	1					
13					1	1		4	3		2							
14					1	2	1		2	1	3	1	1					
15				1		1	2	2	6	4	2	2		1	1			
16						1	1	1	4	3		2	1	1				
17								2	1	2	3	2		1				
18								1	2	2	2	2	4	1	1		1	
19									2	3	3	2	3	2				
20						1		1	2	2	2	1	3					
21						1		2	1			1	3	1	2			
22										2	1	2		5	1			
23								1	2	1		2	2		1			
24					1				1		3	4	2	1	3	1		
25							1		1	1		2						
26										1	2		1	2		1		
27											1		2	1	1			
28								1		1		2	2	1				
29										2	1	1	1		3		1	
30									1	1		5	2		2	2		1
31									1	1	3	3	3	1	1			1
32									1	1	1	1	2	1				
33											1	1		1		1		
34											1			2	2			
35								1	2	3			2					
36										1				1	2			
37													1	2		1		
38															1			
39									1					1		1		
40									2	1	1	1		1		2		
41								1			2		2					
42											1	1						
43								1		1	1			1				
44																		
45															1	1	2	

Figure 14. Female Fin Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Area IV

Body length (ft) / Laminations	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
1																		
2																		
3		4				1												
4		1	1	3	1	2	3											
5		7	6	4	8	9	6	4	1									
6		7	8	5	8	8	7	3	1	1					1			
7		3	9	13	12	7	9	7	3	3								
8		4	2	2	10	4	9	5	8	2	2							
9		1	1	3	5	8	6	5	3	2	2	1	1	1				
10		2		4	4	9	5	5	3	4	6		1	2		1		
11			1	2	2	5	5	4	1	2	3	2	2	1				
12			1	1	1		5	2	3	3	3	1	1			1	1	
13				1			5	3	4	4	3	1	2					
14			1		2			3	6	3	5	3		1	1			
15					2		1	1	1	1	2	2	2	2				
16						1		2	2	4	3		1	3	2			
17					3		3	1	2	2		4	1	1	2			
18							1		1	2	6	1		1			1	
19								1	2	4	2		2	1		1		
20									1	1		1	4				1	
21					1	1			2	1	5	2	3	3	1		1	
22			1				1				2	2	1		5			
23										1	1	4	3		3	1		
24							1	1	1	1	2	5	5			3		
25										2	2	1	1	3	1			
26									2		3		2	2		2		1
27									1	2	3		2	3		3		1
28									1	1	1	3	1		1	1		
29									1	2	1		3	1		1		1
30								1			1	1		2	1	1		
31										1	1	1		4				
32											3	2		1	1	2		
33									1	1	1		2	1		2		
34													3		1		2	1
35											2	2		1			2	
36												1	3		2			
37											1	2				1	2	
38								1	1					2		1		
39						1		1			1		1	1			1	
40											1		1	2		2	1	
41									2	1	1	2	2		1	1		1
42								1				1		1				1
43									1									
44											1							
45													1					

Figure 15. Female Fin Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Area V

Body length (ft) / Lamination	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
1																		
2																		
3																		
4			1		1													
5			2	4	2				1									
6	1		2	2	5	1		2	2	1					1			
7			3	4	2		3		1									
8	1		3	2	1	1	1			1	2							
9			3	1	1	2	1			1	1							
10	1			1	1	1	1	4	4			1				1		
11					1		1				2							
12							2	1	1									
13							1		1	1	1	1						
14			1		1			1	2	2	2		1		1			
15						1	1			2								
16							1				1			1	1			
17									2		1	1						
18							1	1		2	3	1			1			
19										2			1	3				
20									1	1		1	1		1			
21											2	1	2	1				1
22										2	1			1	1		2	
23									1	3	1		1	1	2	1		
24												1		1	2	1		1
25									1			1	1	1		1		
26												3		1	2			1
27											1	4	1				1	
28										1			2		1			
29										1	1		4	2				
30														1	2			
31													1	2	1			
32											1		1	1		2		1
33										1	1	2	3	4	2	1	2	
34											2	3						
35									1	2				1		1	1	
36									2				1			1		
37														2	1	1		
38													1		1	2	1	
39												1		1	1	1	1	
40											1		1		1			
41														2				
42																		1
43												1	1	2		1		
44																1		
45													2		1			

Figure 16. Male Sei Whales Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Areas II-III

Body length (ft) Laminations	41	42	43	44	45	46	47	48	49	50
1										
2										
3										
4										
5										
6										
7			1							
8							1			
9		1								
10										
11										
12					1	1				
13					1					
14			1		1					
15			1	1				1		
16					1	1				
17				2	1	1				
18			1	1		1		1		
19									2	
20				2	1	2	2	1	1	
21	1		1	1	1		1			
22					2					
23				1	1	1				
24						2	3			
25			1		2	1			1	
26				1		1	1	1		
27		1			1	2	1	1	1	
28				2	1	2	2			
29						1				
30							2		1	
31										
32							1	1	1	
33					1		1			
34				1		2			3	
35					1	1	1	1		
36					3	1	1	2		
37			1		1			1		
38					1		1		1	
39	1					1				
40						2		1	1	
41						3		2		
42		1								
43						1				
44										
45										

Figure 17. Male Sei Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Area IV

Body length (ft) / Laminations	41	42	43	44	45	46	47	48	49	50
1										
2										
3						1				
4										
5										
6										
7										
8										
9										
10										
11				1						
12										
13										
14							1			
15									1	
16										
17										
18							1			
19							1			
20			1							
21				1						
22										
23					1		2		1	
24								1		
25							1			
26					1			1		
27				1	1		2			
28					1	1				
29							1	1		
30										
31			1				1			
32					1			1		
33										
34						1				
35						1				
36									1	
37					1	2			1	
38							1		1	
39						1				
40										
41							1	1		
42										
43								1		1
44				1						
45										

Figure 18. Female Sei Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals of Observations

Areas II-III

Body Length (ft) / Laminations	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8				1					1			1						
9																		
10					1													
11										1	1							
12									1			1						
13																		
14											1							
15																		
16										1		1	1		1	1		
17										1	1					1		
18											1	2		2	1			
19										1					1			
20							1			1	1		1					
21									1	1	1		2					
22							1		1		1	2						
23						1		1					1					
24													1			1		
25										1			1					
26									1			1	1	1				
27									1			1	1		1			
28												2	1	1				
29											1					1		
30										1		2						
31								1										
32														1	1			
33												1	3					
34																		
35												1	2					
36													1	1				
37										1								
38																		
39																		
40																		
41										1								
42																		
43											1				1			
44																		
45																		

Figure 19. Female Sei Whale Body Length vs Count of Ear-Plug Laminations (Compiled by Biologists at the Japanese Whaling Institute)

Numbers Indicate Totals Of Observations

Area IV

Body length (ft) / Laminations	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
1																		
2																		
3																		
4																		
5																		
6								1										
7				1	1													
8								1										
9																		
10							1											
11										1								
12									1									
13												1						
14																		
15																		
16																		
17																		
18													1					
19										1								
20																		
21																		
22											1							
23										1					1		1	
24																		
25																	1	
26											1	2			1			
27											1			1				
28											1							
29																		
30																		
31														1				
32																		
33															1			
34																		
35												1						
36																		
37																		
38														2				
39																		
40												1						
41																		
42													1					
43											1							
44																		
45																		

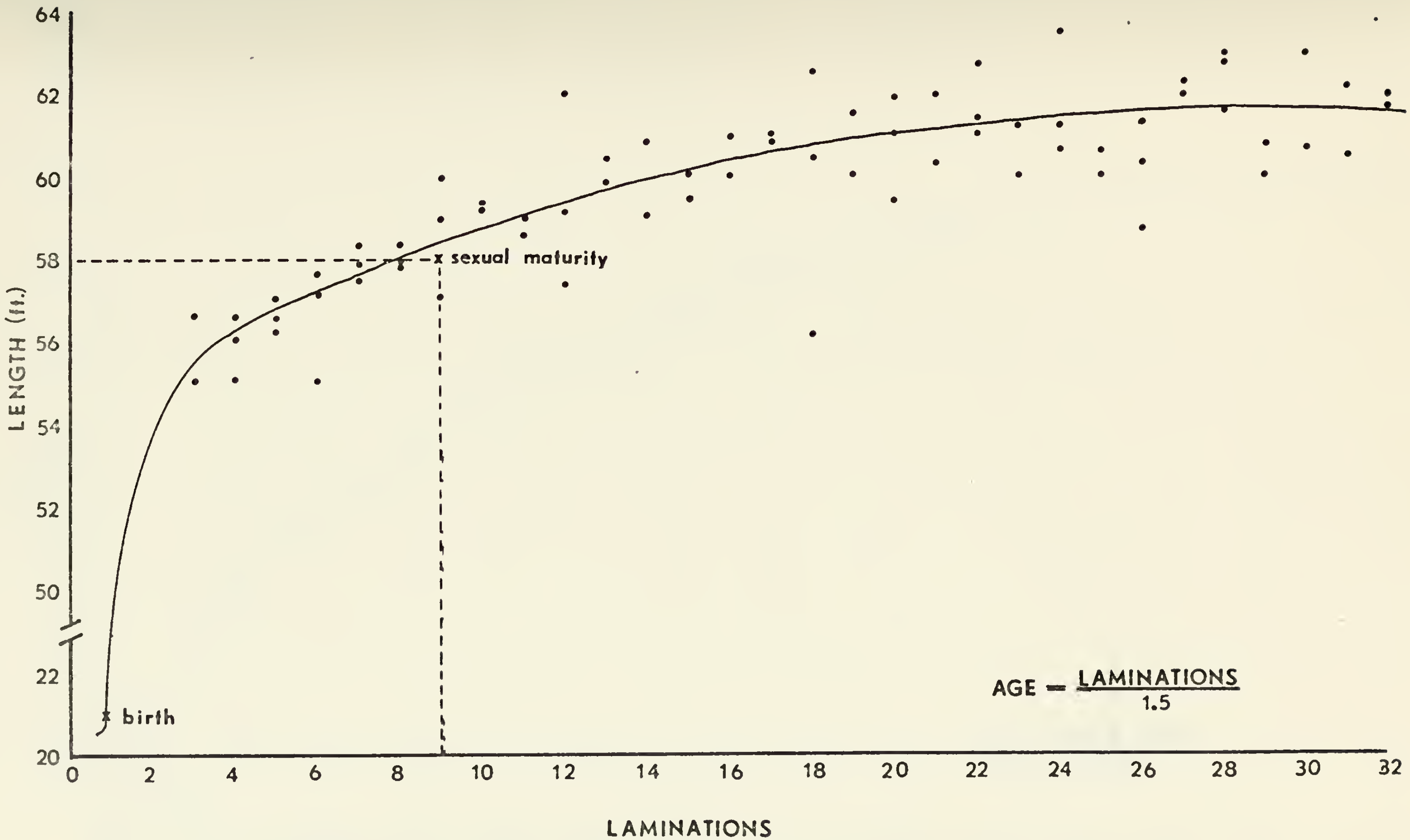


Figure 20. Male Fin Whale "Age-Length Curve": Age is computed from above mean values of data for body length vs ear-plug laminations (data from Japanese Whaling Institute provided by K.R. Allen, Fisheries Research Board of Canada).

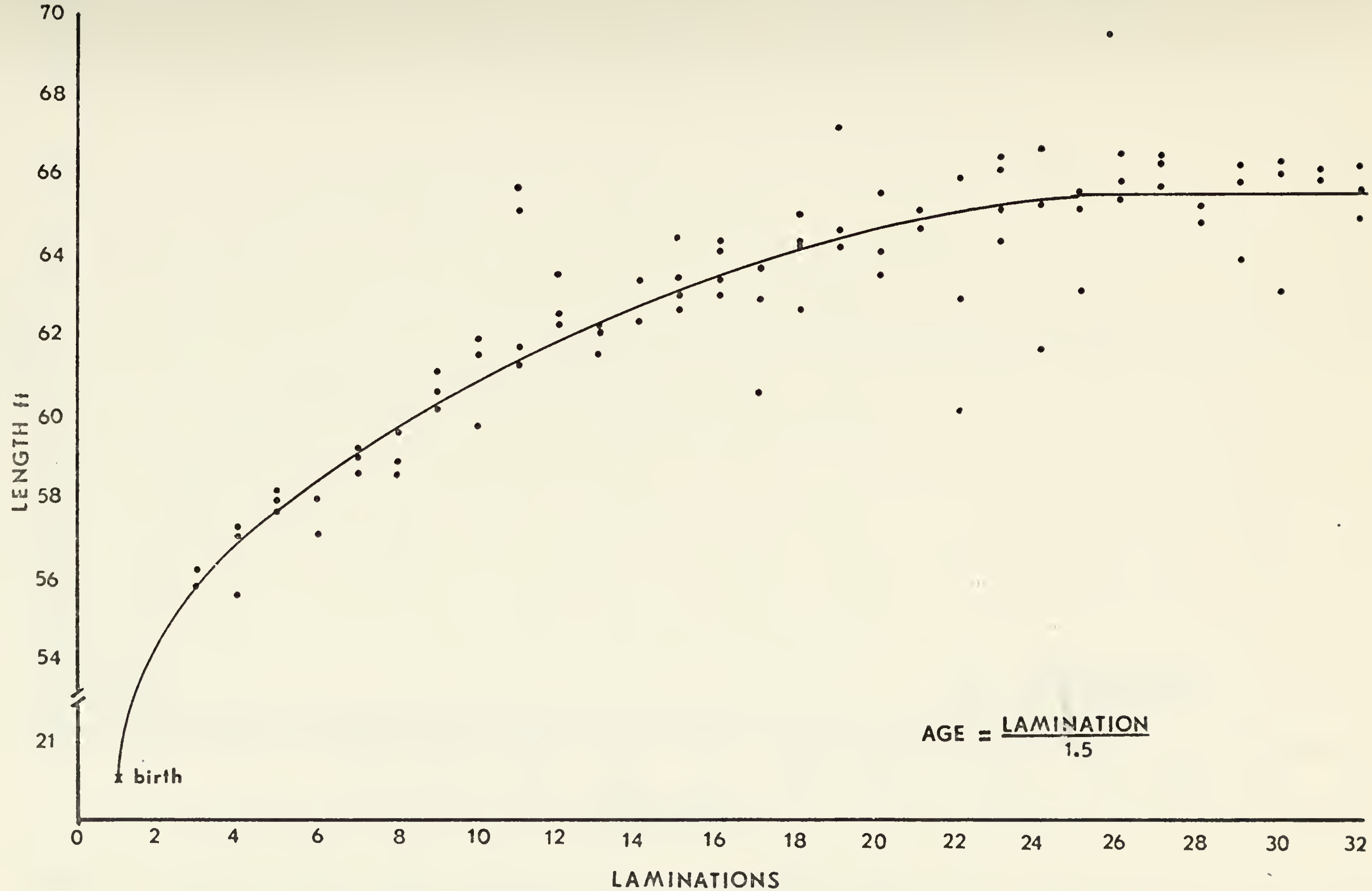


Figure 21. Female Fin Whale "Age-Length Curve": Age is computed from above mean values of data for body length vs ear-plug laminations (data from Japanese Whaling Institute provided by K. R. Allen, Fisheries Research Board of Canada).

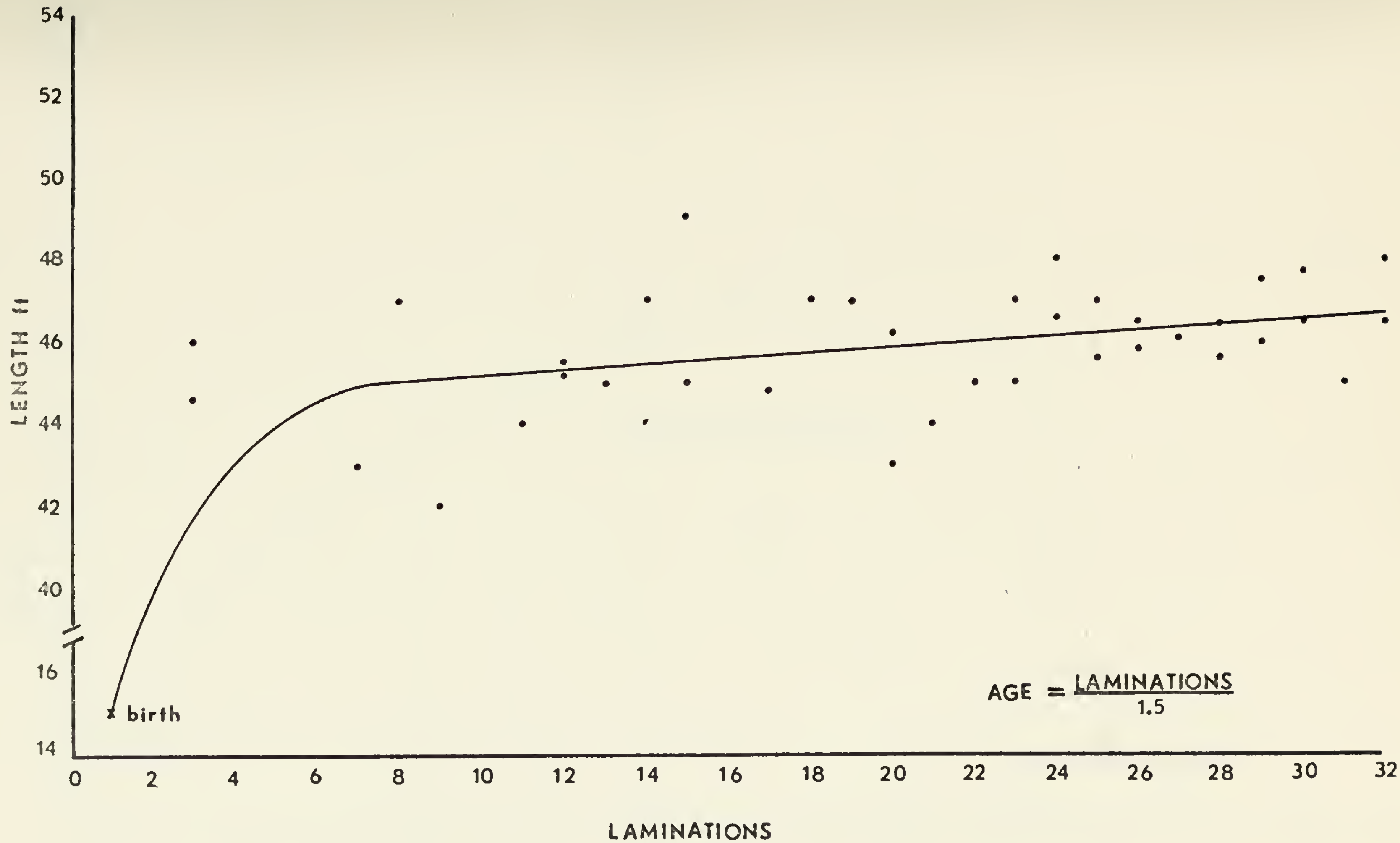


Figure 22. Male Sei Whale "Age-Length Curve": Age is computed from above mean values of data for body length vs ear-plug laminations (data from Japanese Whaling Institute provided by K.R. Allen, Fisheries Research Board of Canada).

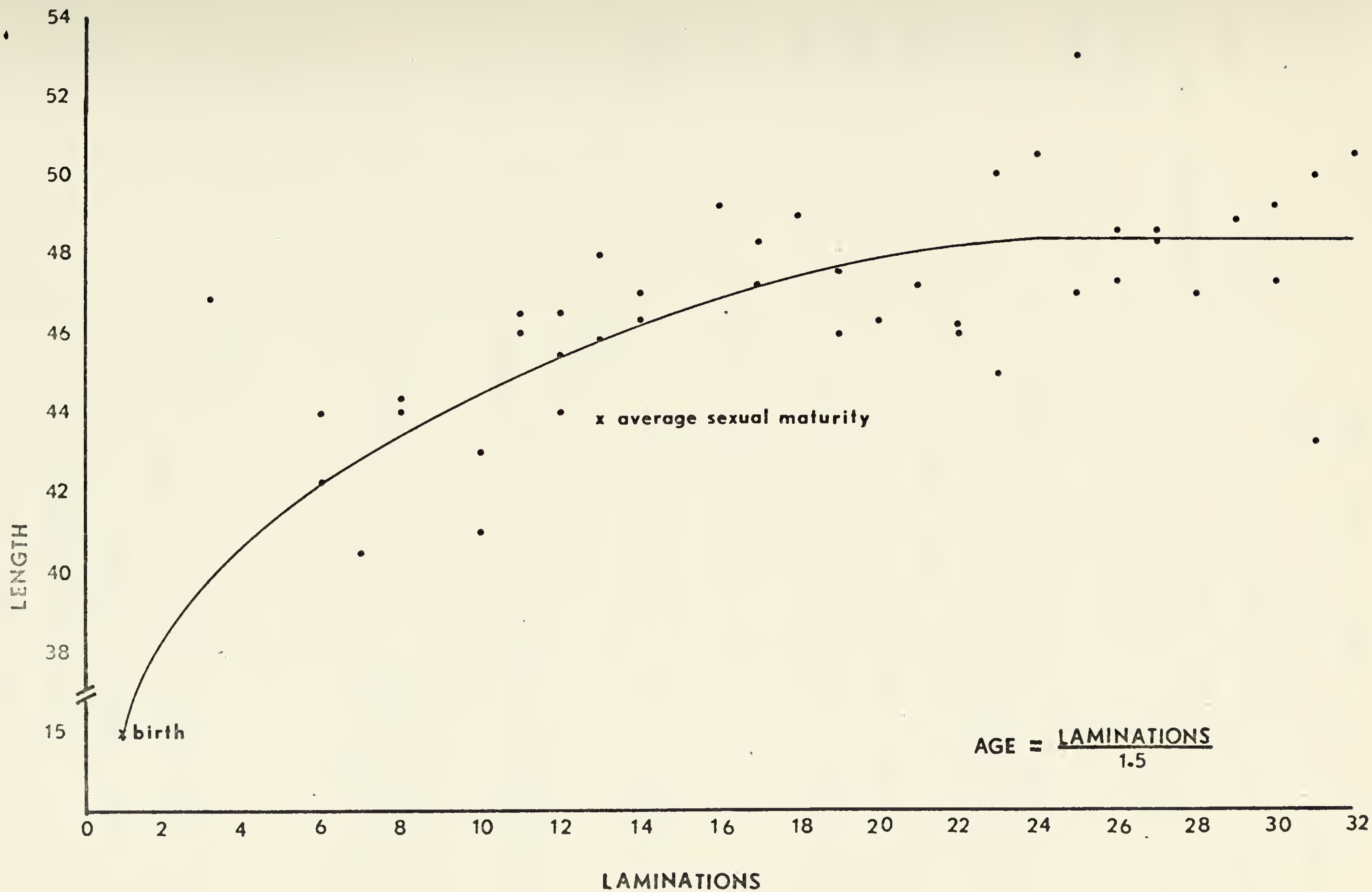


Figure 23. Female Sei Whale "Age-Length Curve": Age is computed from above mean values of data for body length vs ear-plug laminations (data from Japanese Whaling Institute provided by K.R. Allen, Fisheries Research Board of Canada).

A best fit curve was determined for each length lamination frequency diagram by the least squares method using the LSQPL 2 subroutine in the W.R. Church Computer Center library. This subroutine has a maximum capacity of one hundred points. For length-frequency diagrams having more than this number of observations, the mean value of body length was calculated for each number of laminations and the least squares curve fitted to these points.

The individual curves obtained were then plotted, Figures 20-23, and a mean curve determined by applying the known lengths and ages of physical and sexual maturity to these curves. The final curve is approximately exponential in form and agrees reasonably well with von Bertalanffy's theoretical growth equation (Mackintosh 1965, Laws 1959):

$$l_t = L \ (1-e^{-k(t-t_o)})$$

where:

l_t = length at any age

L = mean length at physical maturity

k = a constant determined by the physiological characteristics of the animal

A computer program designated AGEPROP (see Appendix B) was written to calculate the proportion of each age group in the catch, based on the age-length curves.

C. EXPECTED CATCH METHOD

The basic concept of this method is to obtain an estimate which minimizes the sum of the squares of the differences between actual and expected catches. The unknown parameters are the initial population size, N, and the ratio, q, between the instantaneous fishing mortality,

F, and the fishing effort, X. Natural mortality is assumed constant, and recruitment is obtained by examination of the age structure in successive years. The method constructs the population in successive years by taking the initial population, subtracting the actual catch, subtracting mortality, and adding recruitment. This process is repeated in successive years using each estimate obtained as the initial population for the following year. The expected catches are then obtained for each year by dividing the estimated average population during the season by the estimated fishing mortality rate. The mortality rate is obtained by multiplying q times the known effort. The method assumes that catching, natural mortality and recruitment proceed successively thereby simplifying the calculations. The essence of the method is paraphrased here; for further detail the reader is referred to the original paper (Allen, 1966).

Mathematically, letting C_t and X_t be catch and effort respectively, then:

N_1 = initial population

$(N_1-C_1)e^{-M}$ = survival to the next year

$(N_1 - \frac{C}{2}1)\ qX_1$ = expected catch

Then the following year (N_2):

$$N_2 = \frac{(N_1 - C_1)e^{-M}}{(1 - W)}$$

where W is the number of recruits in the next year.

M is the natural mortality and

C_1 is the catch in year 1.

survival to the beginning of the next season

$$= \left[\frac{(N_1 - C_1)e^{-m}}{(1-W_2)} - C_2 \right] e^{-m}$$

and expected catch

$$= \left[\frac{(N_1 - C_1)e^{-m}}{(1-W_2)} \cdot \frac{C_2}{2} \right] qX_2$$

Continuing in this manner we can show that at the beginning of year t the population equals:

$$N_t = \frac{e^{-(t-1)M}}{\sum_{i=2}^{t} (1-W_i)} \left[N_1 - C_1 - \frac{C_2\,(1-W_2)}{e^{-m}} \cdot \frac{C_i \sum_{j=2}^{i} (1-W_j)}{e^{-(i-1)m}} \cdot \frac{C_{t-1} \sum_{j=2}^{t-1} (1-W_j)}{e^{-(t-2)m}} \right]$$

$$= A_t \quad N_1 - f(C)_{t-1}$$

where: $$A_t = \frac{e^{-(t-1)m}}{\sum_{i=2}^{+} (1-W_i)}$$

and

$$f(C)_{t-1} = C_1 + \sum_{i-2}^{t-1} \frac{C_i}{A_i}$$

In year t the difference between the actual and expected catch is given by:

$$C_t - (N_t - \frac{C_t}{2})\, qX_t = C_t \quad 1 + \frac{qX_t}{2} - qX_t N_t$$

The sum of the squares of the differences, d, for the period year 1 to year T equals:

$$\sum_{t=1}^{T} \left[C_t(1 + \frac{qX_t}{2}) - qX_tN_t \right]^2 = d^2$$

Expanding and regrouping terms yields:

$$d^2 = K + L_q + PN_1q^2 + SN_1^2 q^2 + U_q^2$$

where the coefficient:

$$K = \Sigma C_t^2$$

$$L = \Sigma C_t^2X_t + 2 \Sigma C_tX_tA_tf(C)_{t-1}$$

$$P = 2 \Sigma C_tX_tA_t$$

$$R = -\left[\Sigma C_tX_t^2A_t + 2 \Sigma X_t^2A_t \; f(C)_{t-1}\right]$$

$$S = \Sigma X_b^2A_t^2$$

$$= \frac{1}{4} \Sigma C_t^2 X_t^2 + \Sigma C_tX_t^2A_tf(C)_{t-1} + \Sigma X_t^2A_t^2f^2(C)_{t-1}$$

where all terms are summed from t = 1 to t = T.

The normal equations for which the sum of squares is a minimum are obtained by differentiating with respect to N_i and q and setting equal to zero. Thus:

$$\frac{\partial d^2}{\partial N_1} = P_q + R_q^2 + 2SN_1q = 0$$

$$\frac{\partial d^2}{\partial q} = L + 2 q + PN, + 2 RN_q + 2 SN,^2 q = 0$$

Solving for N_i and q gives:

$$N_1 = \frac{LR - 2P}{RP - 2SL}$$

$$q = \frac{RP - 2SL}{4SU - R^2}$$

Once N_1 has been estimated, the populations for subsequent years can be estimated by:

$$N_t = A_t \left[N_1 - f(C)_{t-1} \right]$$

III. RESULTS

Figures 24-32 are average monthly estimates of the number of whales which will be encountered as false sonar targets in 1000 nautical miles of steaming with a 1000 yard sonar range, assuming ideal sonar conditions. The values for expected false targets with other sonar ranges may be obtained by multiplying these estimates by the sonar range in kiloyards.

It can be seen that the false target threat exists in three major areas: a northern area extending across the North Pacific encompassing the Aleutian Islands and the Bering Sea; a central area adjacent to the coast of Japan; and a southern area in the Central North Pacific from 30°N-40°N which broadens to 50°N in the area east of 160° W.

The concentrations of whales as false targets in the northern region gradually increases and spreads from west to east beginning in April with the northern migration of fin and sei whales along the coast of Japan into the Aleutian waters and Bering Sea. The maximum of sixty-three false targets per 1000 nmi is reached in the southern portion of this northern area in August. At this time, the feeding fin and sei whales are accompanied by the maximum of male sperm whales which have migrated from the equatorial regions. In subsequent months, the number of whales in the northern region decreases and shifts westward as the whales migrate southward to their winter grounds in warmer waters. This area is virtually empty of whales from December to late March.

In the central region adjacent to Japan, the minimum concentration also occurs during the period January through March. The population begins to increase in early April due to the northward migration of fin

and sei whales and later with the more general spreading of male sperm whales.

The central region exhibits a bimodal distribution; the first peak in June is due to the northern migration of fin and sei whales and the second maximum is in October and corresponds to the peak southern migration. This second maximum of thirty whales per 1000 nmi is greater than the first of 9 per 1000 nmi. This is because the southward migration of both fin and sei whales closely coincides while the northern migration is distributed over a longer period of time (Kellog 1929).

The southern area shows its initial increase in May in the eastern region due to the arrival of sperm whales along with the appearance of some fin whales off the west coast of the United States. The population of this region reaches a maximum in July, coincident with the passage of fin whales into the northern region. Concurrently, young male, female and calve sperm whales arrive in the Central North Pacific and spread along 30°N. The sperm whale maximum occurs in Spetember and then decreases until, in November, this area is also virtually empty of whales.

The total estimated populations of fin, sei and sperm whales in the North Pacific north of 30°N, for the years 1966-1970, are listed in Table II. Results are provided for both the "q" and Expected Catch methods of population dynamics. Areas III through VI contain estimates based on combined Japanese and Russian data, while Area II contains Russian data only. The blank squares represent areas for which the particular method produced anomalous negative results and do not appear in the table. Direct comparison, from the table, of the results generated by the two methods is difficult since the Expected Catch method yields the population at the start of the season and the "q" method yields the population at mid-season.

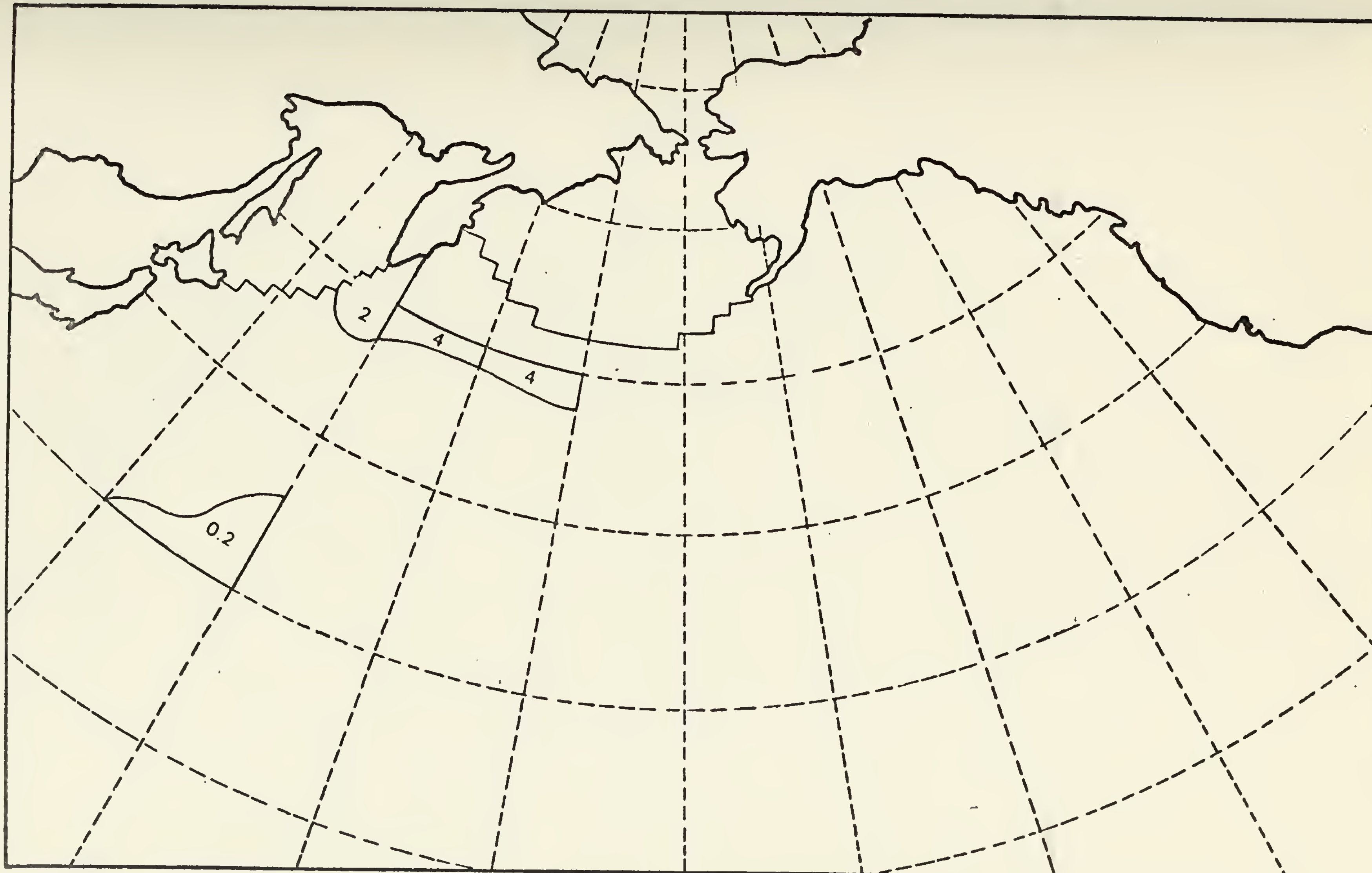


Figure 24. Probable False Target Distribution Per 1000 nmi of Steaming with 1000 Yard Sonar Range by Rho Method Assuming Ideal Sonar Conditions - April.

Figure 25. Probable False Target Distribution Per 1000 nmi of Steaming with 1000 Yard Sonar Range by Rho Method Assuming Ideal Sonar Conditions - May.

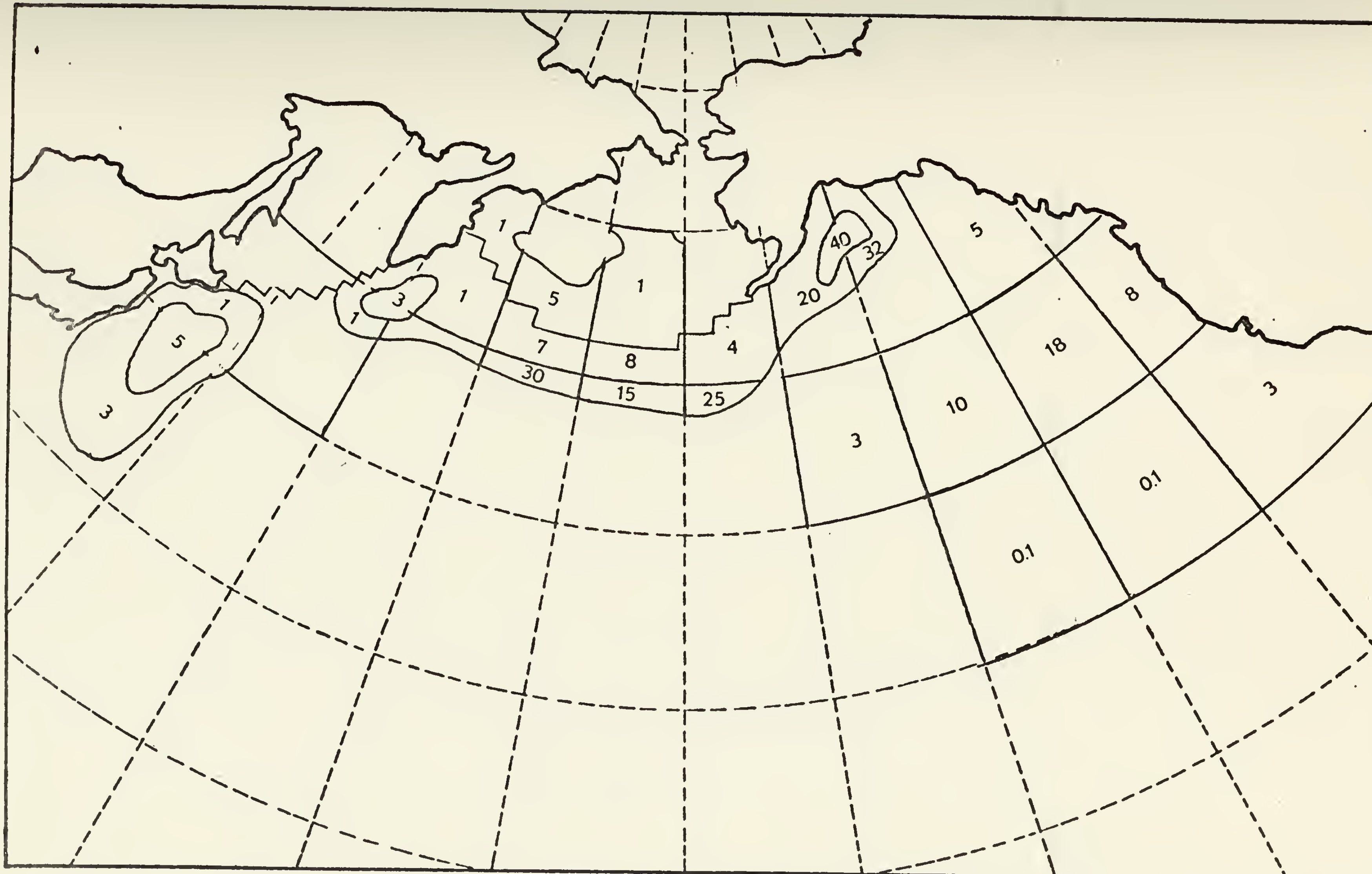


Figure 26. Probable False Target Distribution Per 1000 nmi of Steaming with 1000 Yard Sonar Range by Rho Method Assuming Ideal Sonar Conditions - June.

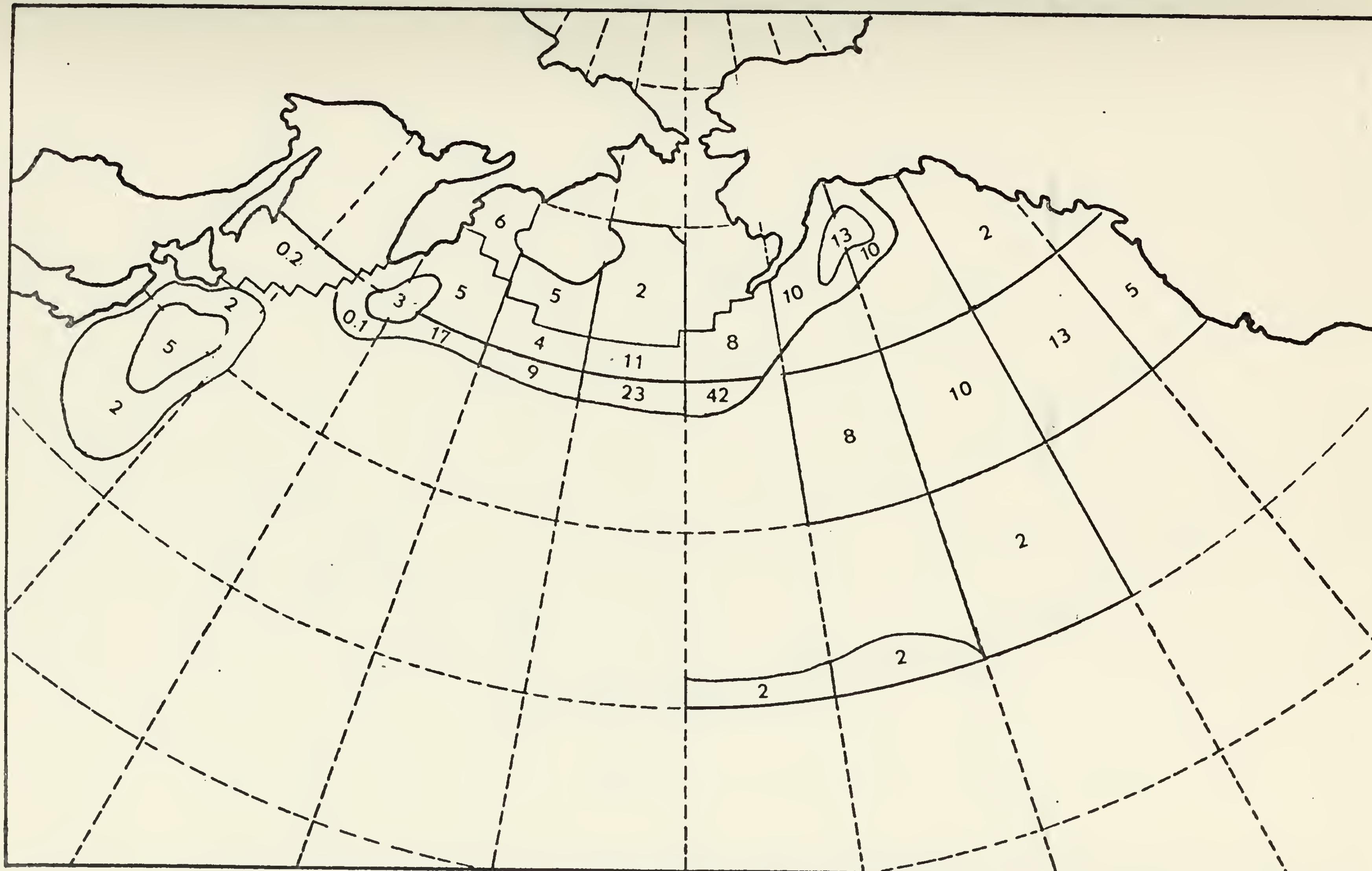


Figure 27. Probable False Target Distribution Per 1000 nmi of Steaming with 1000 Yard Sonar Range by Rho Method Assuming Ideal Sonar Conditions - July.

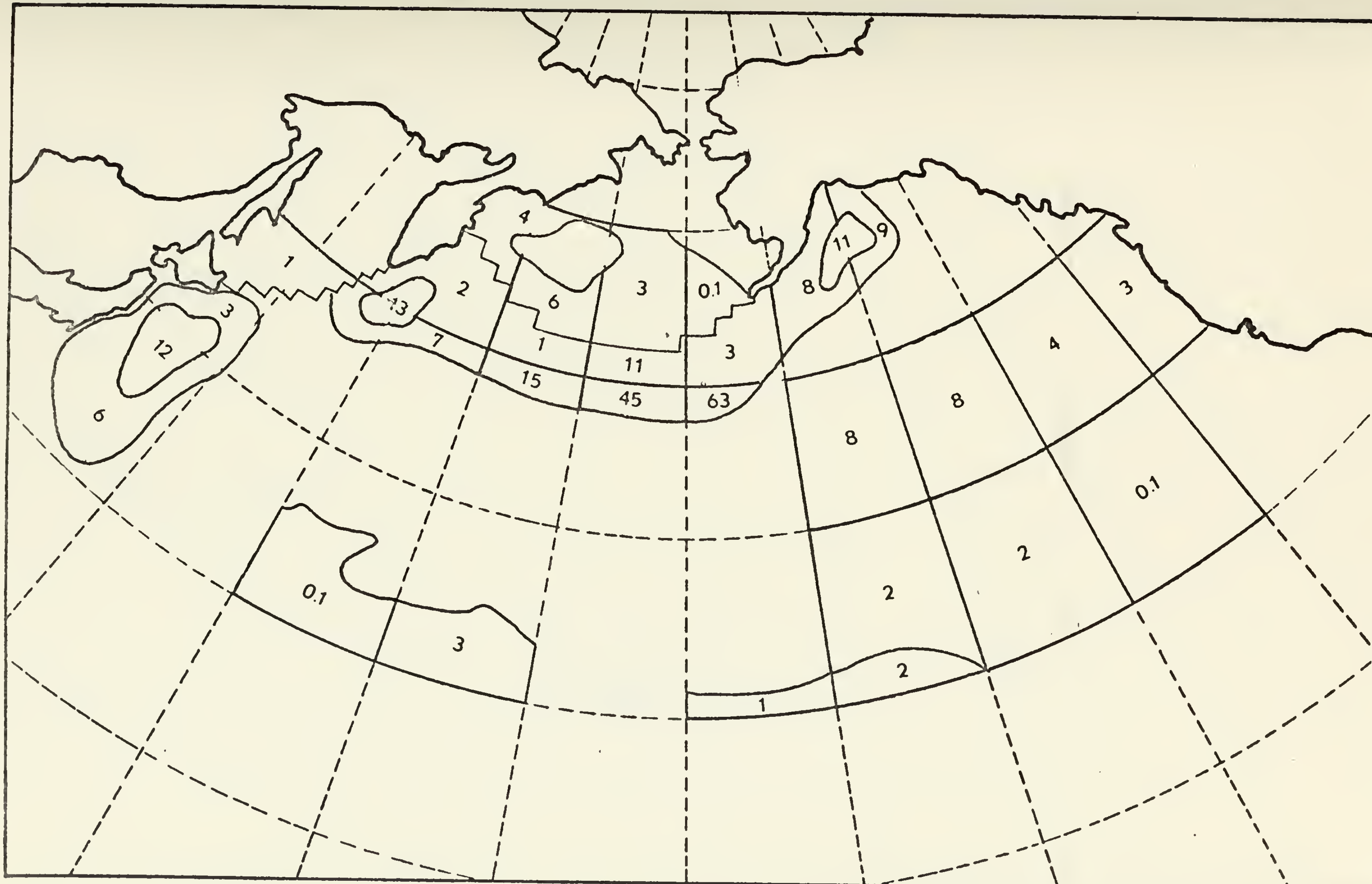


Figure 28. Probable False Target Distribution Per 1000 nmi of Steaming with 1000 Yard Sonar Range by Rho Method Assuming Ideal Sonar Conditions - August.

Figure 29. Probable False Target Distribution Per 1000 nmi of Steaming with 1000 Yard Sonar Range by Rho Method Assuming Ideal Sonar Conditions - September.

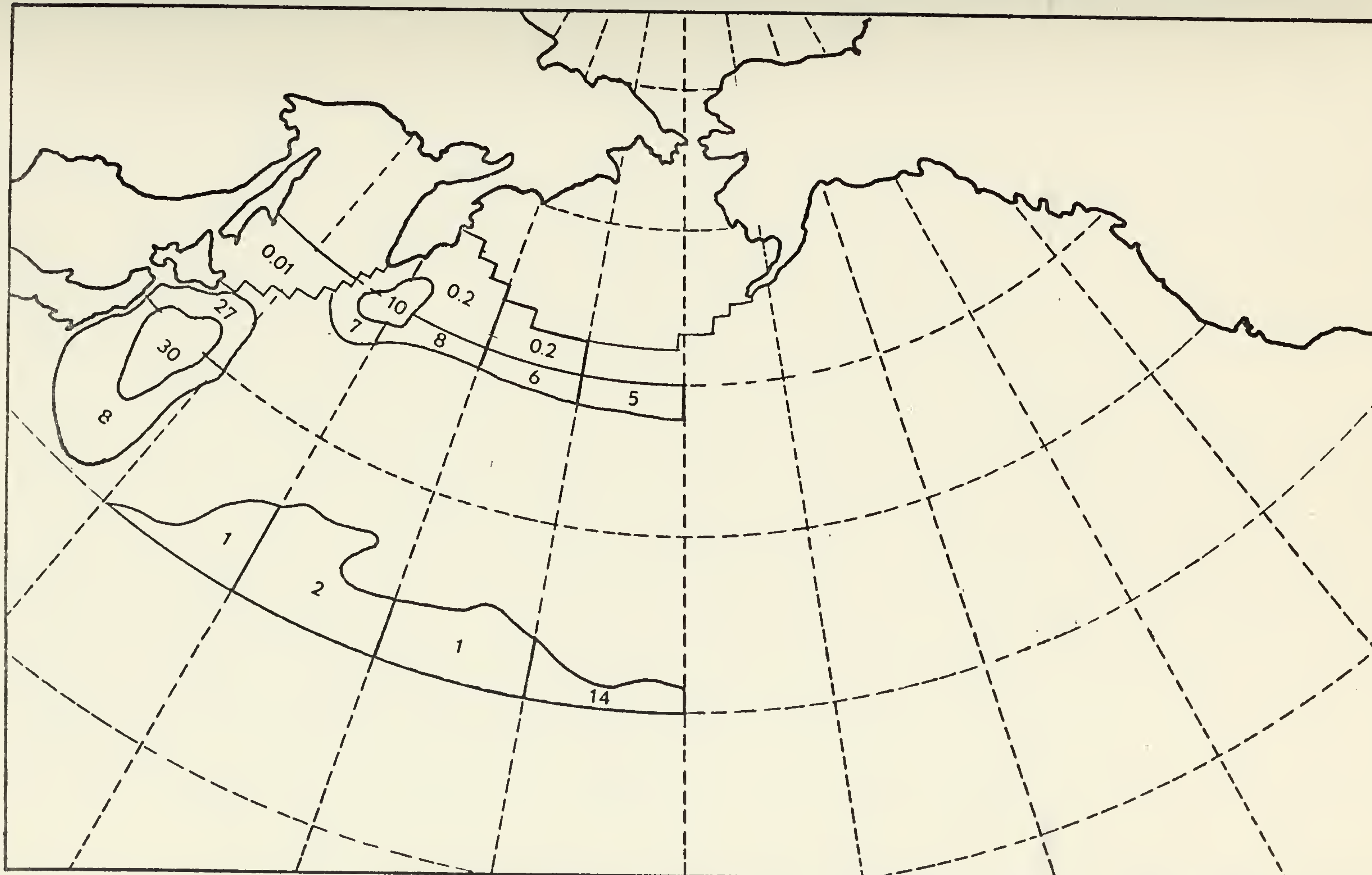


Figure 30. Probable False Target Distribution Per 1000 nmi of Steaming with 1000 Yard Sonar Range by Rho Method Assuming Ideal Sonar Conditions - October.

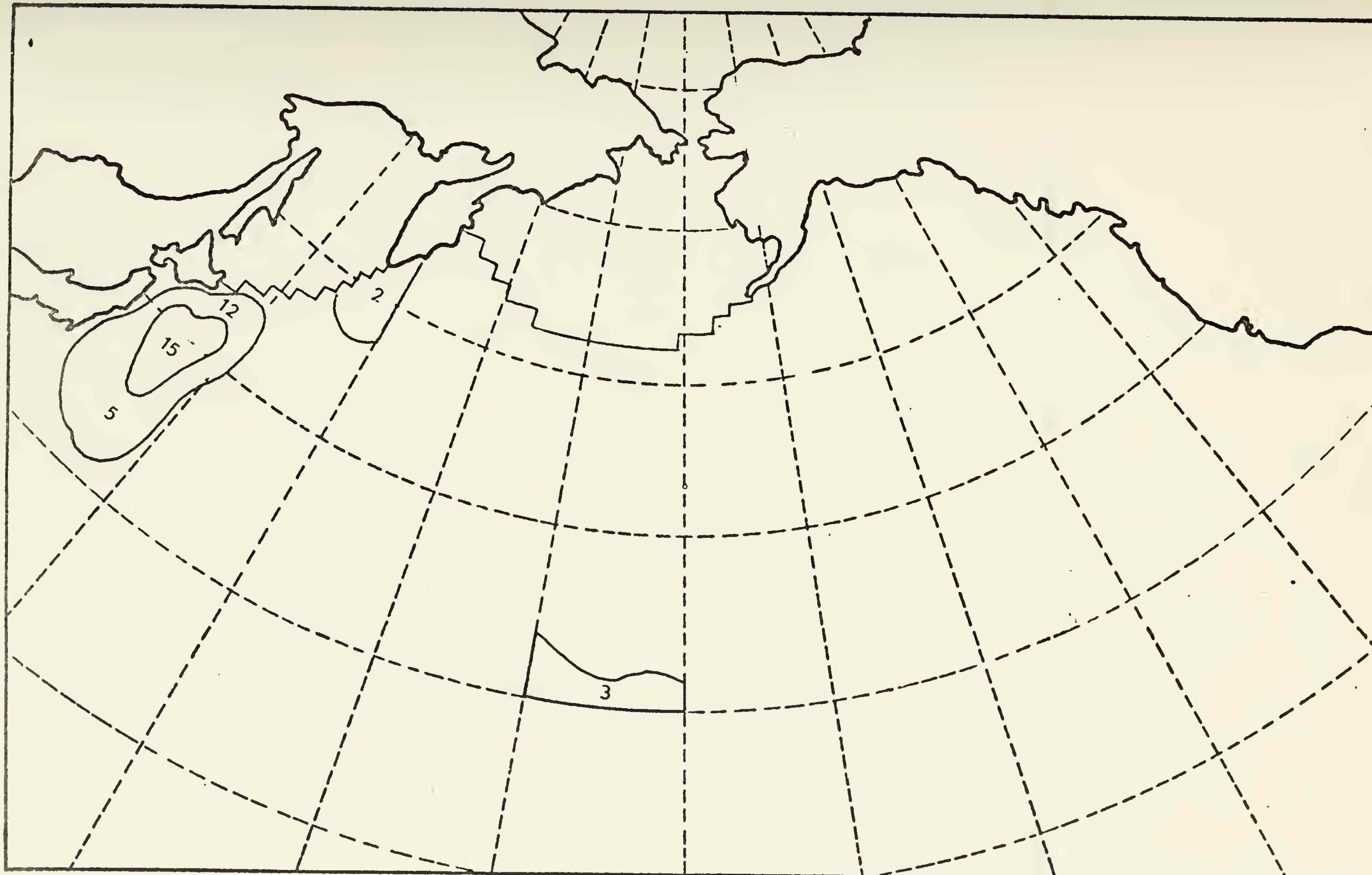


Figure 31. Probable False Target Distribution Per 1000 nmi of Steaming with 1000 Yard Sonar Range by Rho Method Assuming Ideal Sonar Conditions - November.

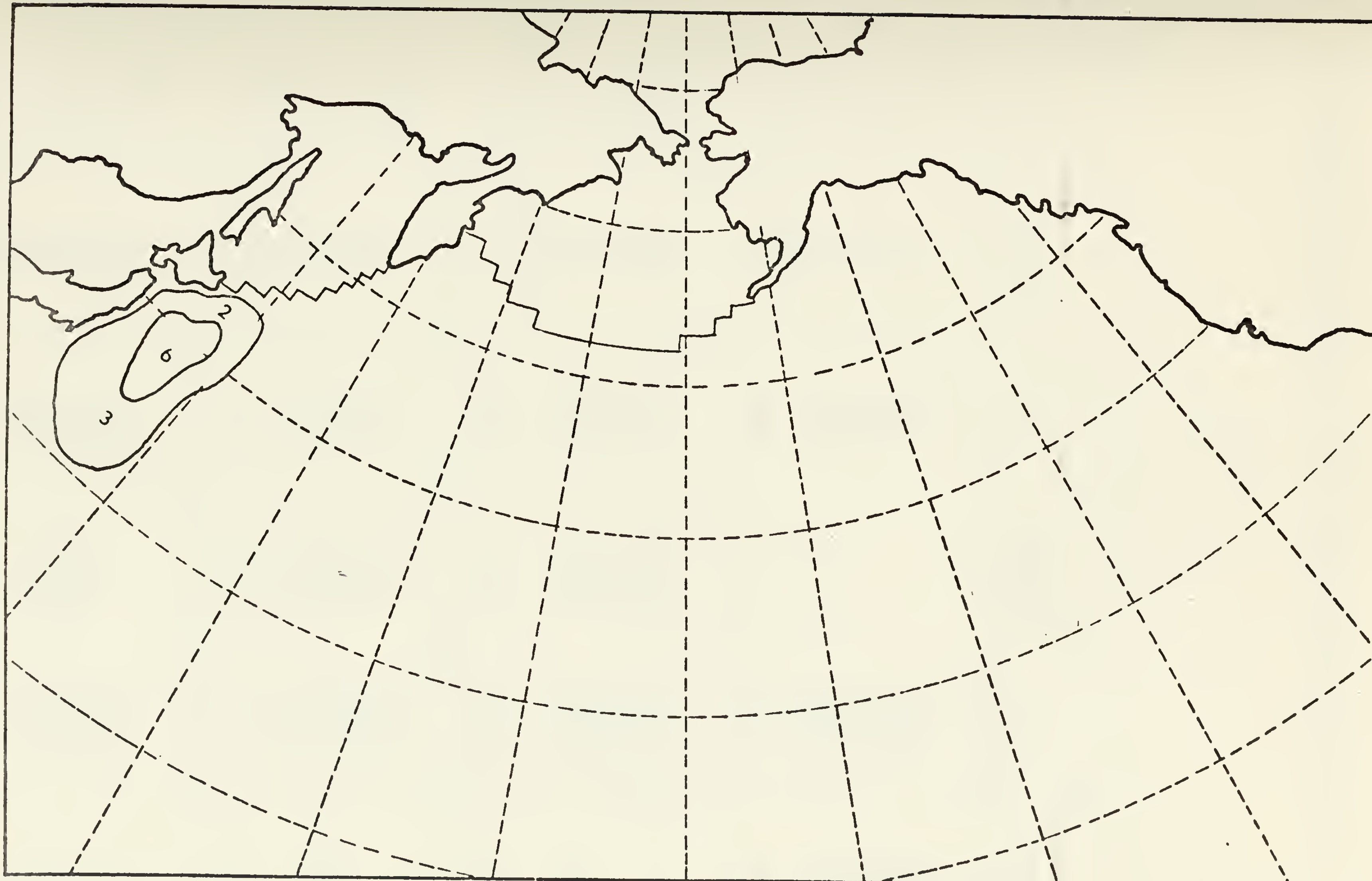


Figure 32. Probable False Target Distribution Per 1000 nmi of Steaming with 1000 Yard Sonar Range by Rho Method Assuming Ideal Sonar Conditions - December.

TABLE III

CALCULATED POPULATIONS OF FIN, SEI AND SPERM WHALES IN THE NORTH PACIFIC BY THE "q" AND EXPECTED CATCH METHODS

1966-1970

AREA II - V

Calculated Populations					
Fin		Sei		Sperm	
"q" Method	Expected Catch	"q" Method	Expected Catch	"q" Method	Expected Catch
AREA II					
8423	1124	2183		21455	39913
8813	1120	4441		25404	40399
7188	1079	1890		22176	40461
4113	710	1303		16335	38939
5265	613	2934		25637	37191
Average population N_i					
6761	929	2550		22201	39381
AREA III					
12402	1299	11017	5943	20383	
4890	449	4268	5382	31568	
5038	360	18778	5968	38222	
1948	264	28746	6219	20760	17500
4026	211	8531	6158	21316	
Average population N_i					
5661	517	14268	5934	26450	17500
AREA IV					
3589	2719	3517	9657	15734	
3526	1966	9442	9872	21573	
9836	1677	4637	9484	19297	22100
3662	1525	5251	10694	21267	27300
1991	1181	3319	11062	23208	
Average population N_i					
4521	9068	5233	10153	20216	24700
AREA V					
2757	4853	4579		17124	20177
5185	4554	8620	9601	14362	20724
4302	4034	8237	8437	11501	21416
4075	3614	4667	6071	9833	21970
2252	3460	4090	4856	13161	22679
Average population N_i					
3714	4103	6039	7241	13194	21392

TABLE IV

CALCULATED POPULATIONS OF FIN, SEI AND SPERM WHALES IN THE NORTH PACIFIC BY THE "q" AND EXPECTED CATCH METHODS

1966-1970

AREA VI

Calculated Populations					
Fin		Sei		Sperm	
"q" Method	Expected Catch	"q" Method	Expected Catch	"q" Method	Expected Catch
AREA VI					
5221	1530	2875		19104	
6340	1506	3986	5063	20807	
3856	1053	7849	4906	17397	
10382	863	3298	4399	13917	
4448	835	5165	4368	20654	
Average population N_i					
6049	1151	4635	4684	18376	

IV. DISCUSSION

A. DATA

The data used in this thesis were extracted from the basic raw data reports prepared by Japanese and Russian whaling institutes for inclusion in the International Whaling Statistics. In their basic form, these reports contain, for each ten degree square, monthly listings of catch by species, sex and catcher effort expended. An annual length-frequency distribution by statistical area is also included. By using these reports, information may be derived for monthly population estimates. Whaling data presented in the International Whaling Statistics are organized by geographic area and seasonal totals and can only be used for estimates of total annual population of the North Pacific.

A serious limitation exists in using whaling data for monthly population estimates in that not all areas are fished in every month. The whaling season is limited by regulation of the International Whaling Commission to six months annually for baleen, and eight months for sperm whales. This limitation is compensated for in part in that the whaling fleet follows the migration of the whale herds and seeks out areas of significant concentration.

A second problem which exists lies in the minimum size limitations of the Commission which are 57 feet for fin (Balaenoptera physalus), sei (Balaenoptera borealis), and sperm (Physeter catadon) whales. Thus the length frequency distribution may not truly reflect the age composition of the catch since certain ages, determined by length, are excluded from the catchable population. This may bias the estimates of recruitment used in the dynamical methods.

Third, due to the seasonal nature of the fishery, data relating to the abundance of whales outside the normal season is virtually non-existent. This results in a period of a year for which no population estimates may be calculated. In this study, this period comprises the months of January, February and March. However, examination of the migratory cycles of the major whale types (Fig 33, Kellog 1929) indicates that very few whales are found in these northern waters in the winter months. The few that persist consist of old sperm and fin bulls which can withstand large temperature extremes. As these whales are usually loners, they should present no significant false target threat.

Finally, the data represents only the catch statistics for the commercially exploited species, fin, sei, bryde's, sperm and, for earlier years, humpback whales. The ramifications of this problem are discussed further below.

B. AGE DETERMINATION

Age determination is important for development of accurate methods in the fisheries biology of whales, and has been the subject of intensive investigation. Of all the age characteristics studied, the accumulated laminae in the ear plug of the external auditory meatus is believed to be most valuable criteria for age determination of the catch (Ichihara 1966). The conical shaped plug consists of alternating layers of dark keratinized cells and bright degenerated fatty cells which form at a rate of one to two per year. It is believed that the formation of alternating layers is in response to the biannual hormonal cycle and periodic changes of food supply. It is assumed that vitamin A, plentiful food supply, and growth hormones result in the formation of a bright layer. Vitamin A deficiency, fasting and estrogen result in formation of a dark keratinized layer.

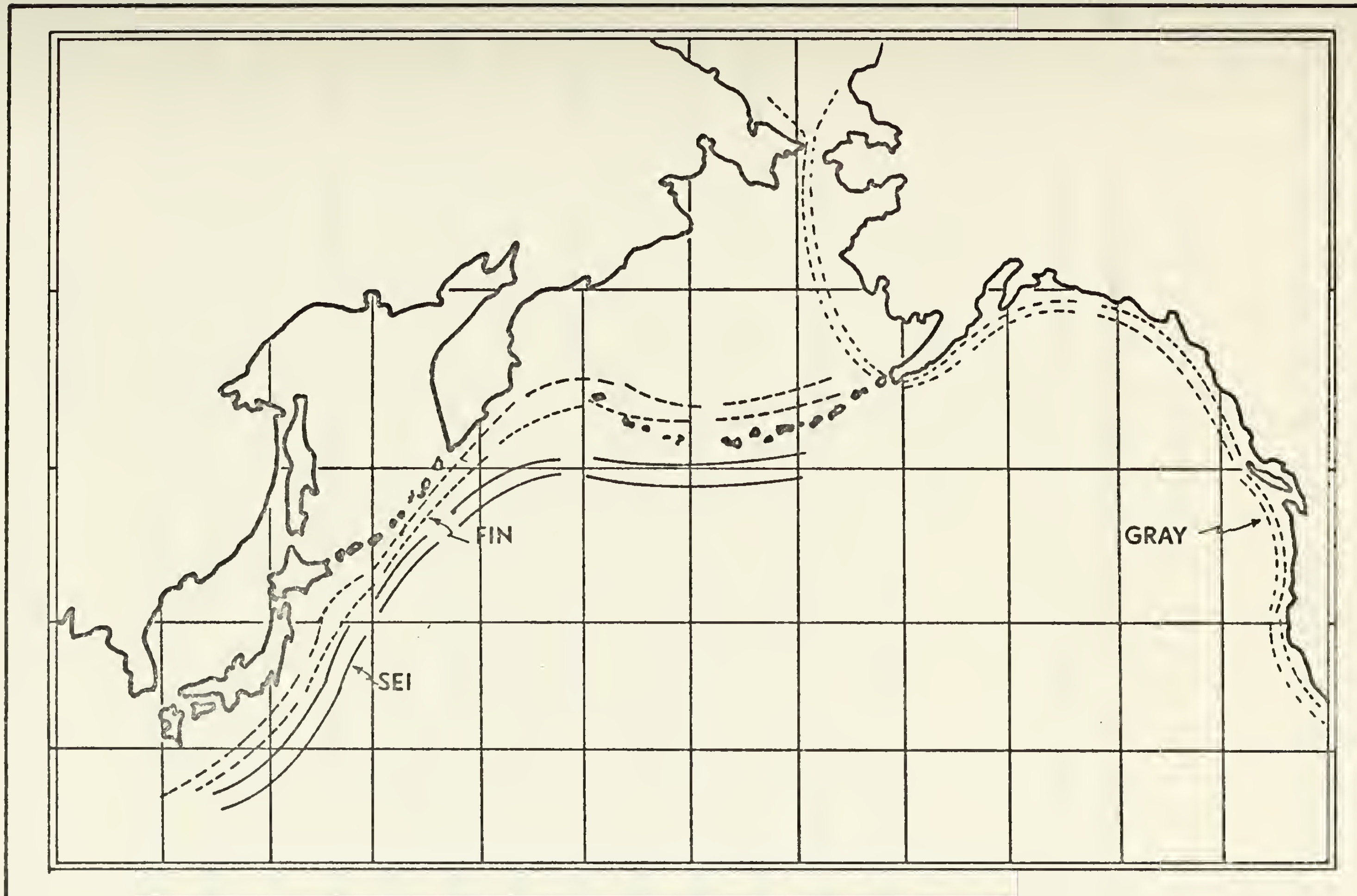


Figure 33. Migratory Paths of Fin, Sei and American Gray Whales in the North Pacific.

The bright layer in the sexually mature whale is formed during the period of feeding migration and the dark layer during a breeding migration.

The annual rate of formation of ear-plug laminations has been a source of disagreement among biologists. Several of the possibilities offered are:

1) one lamina formed per year

2) two lamina formed per year

3) two lamina formed per year until sexual maturity is reached and one lamina per year thereafter

4) 1.5 lamina formed per year.

For the calculations carried out in this paper, age structure was based upon an assumed rate of lamina formation of 1.5 per year for the sexually immature whales. This figure was selected as the most probable estimate in view of work done by Ichihara (1966) who verified it by three methods and Oshumi (1964) who reached the same conclusion by investigation of natural mortality rates. As the same standard is used for age determination of catches in successive years for comparison of year groups, any error introduced is constant in the determined age structure, and is insignificant in the final calculations. Allen (1967) calculated the fin whale population of the North Pacific using three conversions from ear-plug laminations to years (one per year, one per year to five years and then two per year and two per year). His results showed an average difference of only two percent between the calculated populations.

C. AREAS OF DISTRIBUTION

A significant point in the consideration of whale distributions is the identification of the specific areas of distribution. These areas

must be arrived at by examination of the catch statistics in conjunction with the migratory cycles of the animals of interest. Whales migrate in response to two factors:

1) location of areas containing specific foods in sufficient concentration

2) the requirement for a suitable environment for the production and rearing of young.

It can be seen that the composite areas of distribution, Figure 6, closely agree with the zooplankton distribution, Figure 34. This is expected since it is known that the abundance of food controls the limit of migration (Nemoto 1959).

The oceanic structure is intimately associated with the production of zooplankton and, therefore, determines the location of whaling grounds. Vertical and horizontal temperature gradients and vertical stability of sea water masses play an important role in the replenishment of micro-nutrients, mainly phosporic and nitrogen salts. These salts are the limiting factors in the production of phytoplankton, the food supply of zooplankton. Therefore, the highest concentration of whales, and thus the most troublesome false target areas, are those where cold and warm water masses meet and the three basic conditions of light, nutrients and oxygen are present (Ruud 1938, Nasu 1963). It should be noted that whale schools do not concentrate in the rapid, easterly rapidly flowing zones of warm water. Therefore, few whales are found in the west wind drift.

The accuracy of the areas of whale distribution (Figure 6) is substantiated by the fact that in the 1969 season, only 183 whales out of a total catch of approximately ten thousand were taken outside these areas in spite of the efforts of scouting boats to locate new whaling grounds (International Whaling Commission 1969).

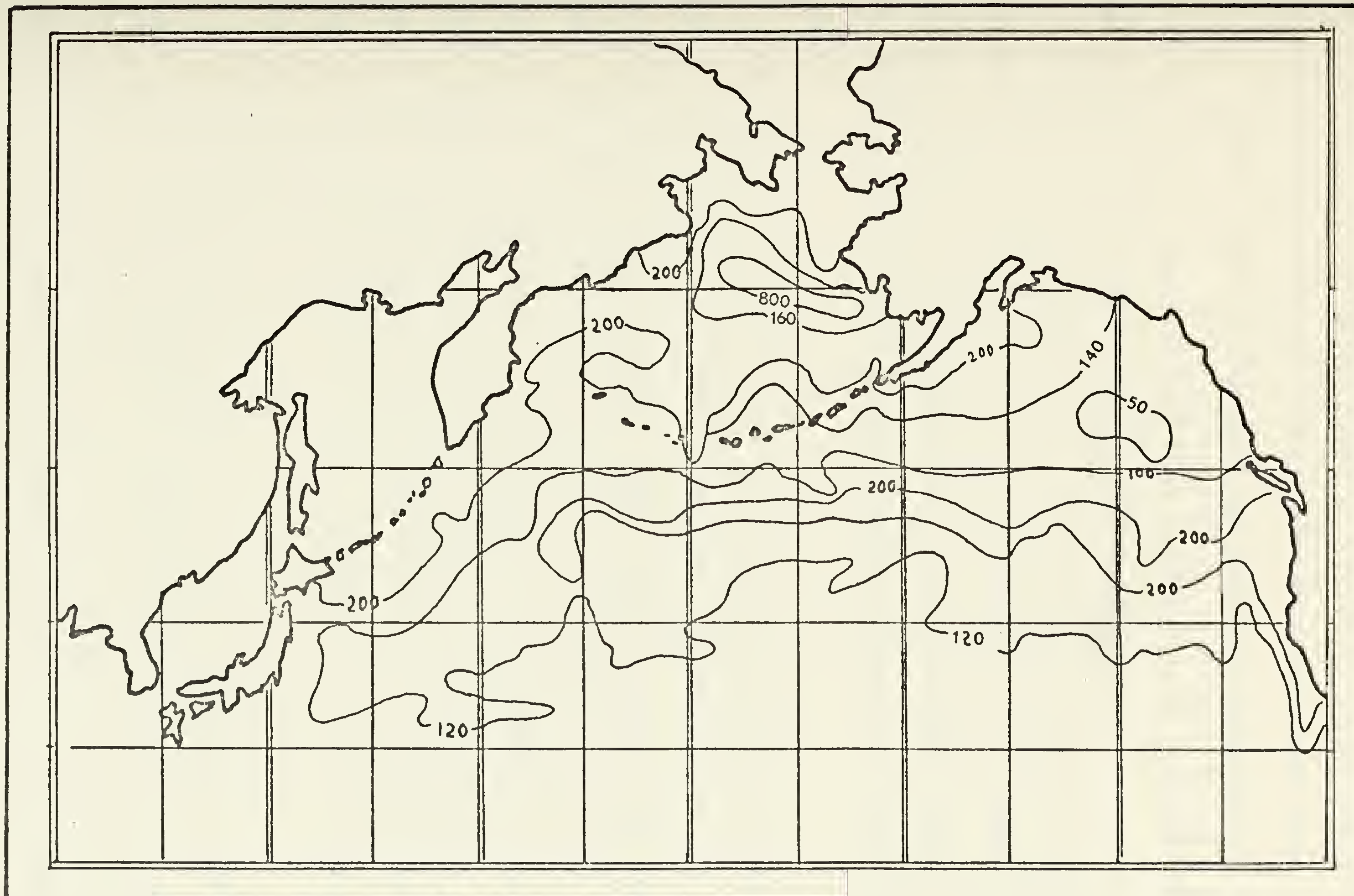


Figure 34. Distribution of Zooplankton volume (parts per 10^9 by volume) in Approximately the Upper 150m of the Pacific Ocean.(after Reid 1962)

D. SONAR PROBABILITY FACTOR

Ideal sonar conditions were assumed in this study; therefore, a value of 1 was used for the sonar probability factor in the application of the modified "Transect Method." Since the effective sonar range is a function of the thermal structure, density and salinity characteristics of the oceanic region, the sonar probability factor will vary seasonally with the meteorological and oceanographic conditions.

ASW units operating in the North Pacific provide the best immediate source of data to evaluate the sonar probability factor and accurately determine the values associated with specific oceanic regions. A feed-back system from operational units would expedite the resolution of this problem.

It is known that the migration and feeding grounds of fin and sei whales are a function of the sea surface temperature and the locations of water mass fronts (Uda 1954, Omura 1955, Uda 1956, Nasu 1957, Uda 1957, Uda 1958, Nemoto 1959, Nasu 1960, Uda 1962, Nasu 1966). It may, therefore, be possible to determine the sonar probability factor through Fleet Numerical Weather Central's thermal structure analysis program. Use of this program may provide prediction of the location of the main body front of the migrating herds of whales, and determination of favorable feeding grounds.

The prototype atlas produced by Leapley and Leavenson (1969) bases prediction of false targets on sighting reports by aircraft and shipping. This approach is limited by several factors. First, whale sighting, especially from aircraft, is seriously hampered by adverse meteorlogical conditions which reduce visibility. Second, the characteristic diving behavior of whales may result in their being unobserved from a rapidly moving platform, i.e. a survey aircraft. These factors could result in

a lesser number of whales being observed in an area than are actually present. On the other hand, when whales are sounding and surfacing the same whale may be counted more than once. This would result in an erroneously high count for the area under observation. Finally, this approach is limited in that no provision is incorporated for variations in sonar conditions. It is felt that the approach taken in this thesis, the analysis of whaling data, can provide more accurate estimates of the false target threat if it is combined with oceanographic research to determine the value of the sonar probability factor. Both can be sent out to the fleet as a part of the Fleet Numerical Weather Central forecast.

E. INCLUSION OF OTHER WHALE SPECIES

This thesis considers only the species of whales hunted and reported on by the commercial fisheries, i.e. fin, sei, brydes (included under sei) and sperm whales. Other whales of importance to the false target problem in the North Pacific include: the Northern Right (Eubalaena sieboldii), Gray (Eschrichtius gibbosus), Pigmy Sperm (Kogia breviceps) and Humpback (Megaptera novae-angliae). Further study and analysis of the distribution and migratory patterns of these whales would provide further refinement of the analysis method presented in this paper.

For example, a census is being conducted this year of the gray whale. At Point Yankee, California, the southern migration reached a peak with the passage of two hundred whales per day (Dr. Dale W. Rice, private communication). The daily count of the passage of the whales past a specific point such as Point Yankee, would yield the distribution of the whale population in migration. This distribution may be combined with the known migratory swimming speed of four knots and the known migratory

paths along the coast of North America into the Bering Sea (Pike 1962, Rice 1971). Thus an estimate of the arrival times of the main body in specific areas can be derived.

F. WHALE SIGHTING PROGRAM

In the Fall of 1971, Dr. Paul Sund of the National Marine Fisheries, initiated a whale sighting program for the Pacific Ocean (Dr. C. Fiscus, Marine Mammal Laboratory, Seattle, Washington, personal communication). Under this program, officers of United States merchant ships are being taught to recognize species of whales swimming through the water and report whales sighted during transits of the Pacific Ocean. These sighting reports will be card punched for computer processing and will provide a valuable source of data on whale distribution patterns when a sufficient quantity of data has been accumulated to give meaningful results.

V. CONCLUSIONS AND RECOMMENDATIONS

The analysis of commercial whaling data for the North Pacific provides a useful method for estimating the false target threat in this area.

Studies should be undertaken to determine the values of the sonar probability factor for those areas identified with significant whale density. This may be accomplished by means of feedback reports from operational units combined with Fleet Numerical Weather Central's thermal structure forecast. These studies should also incorporate the results of the new whale sighting program initiated by Dr. Paul Sund of the National Marine Fisheries, in 1971.

RAW WHALING CATCH DATA JAPANESE 1970 m = male f = female

	M21			N21NP			N210S			P29		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN	1/0	55/47	26/27				1/2	0/1				
FEB												
MAR												
APR												
MAY	1/0	55/47	26/27				1/2	0/1				
JUN	2/1	74/83	27/0		1/2	10/0	1/3	2/2				
JUL	0/1	13/26	48/26	1/3	3/7	39/2	2/3			10/10	25/25	40/8
AUG		5/5	152/116		8/11	32/5	3/2	1/1				57/13
SEP	11/15		335/450	4/6	7/11	33/4	6/11					
OCT	1/4	21/23	312/509	9/10	24/25	140/86						
NOV			109/292			220/112						
DEC			116/240			14/2						

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N30			N28			P28			N29		
JAN												
FEB												
MAR												
APR												
MAY												
JUN					126/136						75/43	
JUL				2/3	56/41	38/0	50/36	32/20	50/0	14/13	298/188	
AUG			0/4	5/4		234/83			0/1	5/2		100/33
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1970 m = male f = female

	P26BS			N27			P27			P25BS		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY					9/12	1/0						
JUN					14/12							
JUL				1/3	1/1	20/0	2/7	4/3	11/0			
AUG	36/33					120/0				17/23	1/0	
SEP						19/0						
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N26			P26NP			P24BS			N25		
JAN	3/6	146/154	41/0							4/2	46/58	24/0
FEB												
MAR												
APR												
MAY	3/6	146/154	41/0							4/2	46/58	24/0
JUN	3/3	178/166	99/0	6/2	2/6	8/0				2/2	42/60	23/0
JUL		5/7	11/0		8/6]				145/17		6/9	10/0
AUG			397/0			8/0		1/0	56/14			147/0
SEP			206/50									15/12
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1970 m = male f = female

	P25NP			P23BS			N24			P24NP		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY							23/19	67/58	25/29			
JUN		4/5	3/0				0/7	191/163	30/18		2/1	44/0
JUL							3/3	58/49			1/1	74/13
AUG						10/13	1/0	14/20	55/0		0/2	
SEP												
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N22NP			N23			P23NP					
JAN												
FEB												
MAR												
APR												
MAY				26/30	69/69	5/23						
JUN				16/7	77/64	1/0						
JUL		1/1		44/30	152/121	20/0						
AUG						95/0		0/4	99/21			
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1969 m = male f = female

	N21OS			N21NP			M21			N23		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY				1/0			0/2	68/47	38/26	47/40	133/67	40/20
JUN					1/1		3/4	49/60	74/33	13/12	372/167	16/33
JUL				6/5	5/8	19/0	0/2	3/11	26/2	17/13	226/85	71/63
AUG	3/2			0/1	11/18	58/0		28/31	227/89			
SEP	2/12	2/3		10/3	16/11	109/116		0/5	395/390			
OCT	1/1			7/11	54/39	266/100		9/7	224/281			
NOV						145/131			107/396			
DEC						93/66			78/276			

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	P23NP			P23BS			N24			P24NP		
JAN												
FEB												
MAR												
APR												
MAY							66/65	126/89	34/42			
JUN							26/20	356/280	41/65			
JUL							0/3	12/0	46/0	0/1		5/0
AUG			145/92			75/60			1/0			37/1
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1969 m = male f = female

	P24BS			N25			P25NP			P25BS		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY				12/3	6/2	9/0						
JUN				7/7	111/71	0/2	0/1	4/1	44/0			
JUL		82/0		28/28	95/54	53/0	6/3	45/39	9/0			
AUG			52/0			8/0			36/0			3/0
SEP												
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N26			P26NP			N27			P27		
JAN												
FEB												
MAR												
APR												
MAY	3/0	57/67	16/0									
JUN	38/41	50/55	14/0					0/3	7/0			
JUL	4/3	31/75	19/0	10/18	55/50	108/0	4/9	35/182	13/0	0/1	2/2	8/9
AUG						164/23	2/2	11/22	63/0			161/43
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1969 m = male f = female

	N28			P28			N29			P29		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL	9/9	246/283	15/2	1/1				12/3				
AUG	3/0	67/60	154/33			16/37		11/6	394/428			17/32
SEP												
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG												
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1968 m = male f = female

	N22NP			P22NP			N23			P23NP		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY	2/2	14/5					32/42	93/82	11/25			1/0
JUN	1/3	9/1					69/73	543/323	44/47	23/21	106/33	12/0
JUL	1/0	22/15		1/1			69/45	203/139	24/42	3/12	1/2	
AUG												
SEP												
OCT												
NOV												
DEC												

	P23BS			N24			P24NP			P24BS		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY				9/9	245/219	33/22			32/7			194/4
JUN			43/0	31/28	382/354	84/163	0/1	34/32	94/27			116/21
JUL				0/5	34/42	24/10	0/1	66/51				
AUG						59/7						26/0
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1968 m = male f = female

	N25			P25NP			P25BS			N26		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY		7/13				15/0						
JUN			116/5			87/0			5/0			27/0
JUL		0/3	103/0	11/14	25/11							406/3
AUG						26/0]	94/59	20/8		0/3	25/13	25/0
SEP												
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	P26NP			N27			P27			N28		
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL		39/27	1/0			323/55			91/0			8/8
AUG	3/0	23/17	15/0	16/10	47/31	51/1	10/11	54/45	169/38		172/71	75/42
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1968 m = male f = female

	P28			N29								
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL						3/15						
AUG	10/4	79/37	10/0			62/42						
SEP												
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N21OS			N21NP			M21					
JAN												
FEB												
MAR												
APR												
MAY							5/3	146/100	6/2			
JUN					1/1	15/10		124/145	34/35			
JUL	1/0	2/0		1/5	3/5	11/4	0/1	47/85	35/51			
AUG	1/0			0/3	27/17	22/0		30/39	254/256			
SEP				4/10	45/72	102/74		1/4	209/517			
OCT				8/11	14/25	126/202		1/5	143/462			
NOV						129/318			78/210			
DEC						30/47			62/263			

RAW WHALING CATCH DATA JAPANESE 1967 m = male f = female

	P22NP			N23			P23NP			P23BS		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY				2/2	5/6				9/0			
JUN												
JUL	33/36	1/2	9/0				46/25	497/236	73/33	163/168	5/2	93/70
AUG				8/11	132/124							
SEP												
OCT												
NOV												
DEC												

	N24			P24NP			P24BS			N25		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY	40/50	248/181	30/2		0/3	134/0			125/0	5/10	88/82	7/0
JUN	8/20	241/167	7/0	4/0	158/109	34/1		1/1	47/0	7/8	280/139	51/6
JUL		19/15	0/2	0/1	33/22	1/33	39/43	11/2	87/0		2/0	178/0
AUG	19/18	46/58								1/0	113/114	135/0
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1967 m = male f = female

	N210S			N21NP			M21			M19		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY					1/0		1/1	44/41	30/4			
JUN	0/2	2/1		0/1	3/3	11/5	0/3	41/43	34/6	6/1		4/1
JUL	10/7	2/2		1/3	8/20			20/31	86/7	6/4		5/3
AUG	5/8	1/0		0/2	10/6	30/35	0/1	10/8	246/263	1/0		2/3
SEP				0/1	24/37	179/141	2/0	4/10	115/186			
OCT				13/16	55/106	138/157		0/1	130/211			
NOV						30/67			139/281			
DEC									31/73			

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG												
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1967 m = male f = female

	P25NP			P25BS			N26					
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY			19/0			113/1						
JUN		7/5	83/0			72/0	7/3	15/10	68/0			
JUL		21/13	9/0	0/2		2/0			121/0			
AUG									516/25			
SEP												
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	P26NP			P26BS			N27			P27		
JAN												
FEB												
MAR												
APR												
MAY												
JUN	20/20	134/75	74/0			7/0						
JUL										8/10	26/8	109/32
AUG									313/36			
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1967 m = male f = female

	N28			P28								
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN	1/0			9/6	13/5	149/93						
JUL												
AUG												
SEP												
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG												
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1966 m = male f = female

	N23			P23NP			P23BS			N24		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR	~~3/3~~	~~4/2~~										
APR												
MAY	3/3	4/2								1/1	2/0	
JUN												
JUL						14/31			26/31		4/3	
AUG				8/13	2/1	57/4	44/45	2/0	65/8			10/0
SEP		48/58			4/8					1/0	6/6	
OCT												
NOV												
DEC												

	P24NP			P25NP			P24BS			N25		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY			65/2	5/10	11/13	20/1			130/0	2/0	3/4	
JUN			102/0			124/23			196/0	2/1	4/0	39/0
JUL		4/6	31/0	10/15	135/103	85/0			161/0	4/10	100/70	52/0
AUG			70/0		0/1	155/0	22/24	32/10	253/26			109/0
SEP		1/2	16/0		16/16	16/0		5/5			31/26	
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1966 m = male f = female

	P25BS			N26			P26NP			P26BS		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY			26/0				28/25	3/6				
JUN			175/0	4/6	39/27	33/0	2/7	6/6	9/0			71/0
JUL	41/37	1/3	82/0	4/0	10/8	22/0	19/23	144/99	135/0			
AUG	38/43	28/12	223/0			61/0		12/10	110/0			
SEP												
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	P27			P28			P29					
JAN												
FEB												
MAR												
APR												
MAY	4/4	0/1										
JUN	21/15	41/34	1/3	250/288	191/97	44/19	10/5	7/5				
JUL	7/4	23/12	35/16	41/39	175/100	2/2						
AUG	2/1	27/12		35/33	190/130							
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA JAPANESE 1966 m = male f = female

	N210S			N21NP			M21			M19		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY						3/2	1/2	11/20	1/1			
JUN					0/2	33/5	2/0	27/48	56/58	2/3		1/4
JUL	4/5			3/1	3/6	18/0		24/36	81/18	8/6		2/1
AUG	25/17	20/3		5/9	6/9	59/31		0/4	197/233			
SEP					6/9	153/106			80/246			
OCT				5/4	14/34	59/38	1/1	2/8	42/100			
NOV				5/4		27/49			78/96			
DEC									66/99			

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG												
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1970 m = male f = female

	M21			N21			N210S			N22		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR										16/23	20/20	195/19
MAY												
JUN												
JUL												
AUG												
SEP												
OCT			177/166		3/1	126/47				8/8	9/5	65/2
NOV			3/17		1/0	7/7				1/2		39/5
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N23			N24			N25					
JAN												
FEB												
MAR												
APR												
MAY	1/2	6/6	69/3	4/7	7/4	66/0	1/3	12/12	90/0			
JUN												
JUL							10/15	22/34	120/0			
AUG				1/1	5/7	287/5	4/9	32/58	824/0			
SEP			29/0		4/2	109/11	0/1	16/29	174/0			
OCT	6/4	16/25	307/4	1/2	2/1	35/1						
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1970 m = male f = female

	N26			N27			N28			N29		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N26											
JAN												
FEB												
MAR												
APR												
MAY	1/5	2/4	54/1			26/2	2/2	16/17	36/7	4/13	17/20	107/27
JUN		5/6	155/1							17/16	30/47	344/78
JUL	1/2		52/0		7/11	87/1	3/8	6/9	31/11			
AUG	34/30	30/35	246/3			28/2						
SEP		3/8	27/1									
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N29			M30								
JAN												
FEB												
MAR												
APR												
MAY												
JUN			11/7			446/190						
JUL												
AUG												
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1970 m = male f = female

	N30			M22			M23			M24		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY	26/26	23/46	138/34									
JUN	35/47	32/42	284/85									
JUL												
AUG												13/7
SEP									119/4			287/119
OCT						92/33			151/43			28/16
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	M25			M26			M27			M28		
JAN												
FEB												
MAR												
APR												
MAY												
JUN												16/3
JUL						330/43			133/48			315/51
AUG			142/9									
SEP			553/150			239/77						
OCT			36/0									
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1969 m = male f = female

	M21			N21			N210S			N22		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY										2/3		130/12
JUN												
JUL												
AUG												
SEP		4/6	83/15			51/3					0/4	37/1
OCT			78/25		13/14	269/34			27/0	8/10	33/31	117/6
NOV			80/4		15/23	109/21						29/7
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N220S			N23			N24			N25		
JAN												
FEB												
MAR												
APR				0/2	4/8	131/8						
MAY						45/1		2/7	31/0		3/3	46/0
JUN												
JUL												48/0
AUG									42/0	1/3	26/28	419/4
SEP				2/1	4/3	48/3				12/17	20/31	188/1
OCT	2/1		11/0	1/0	12/30	150/0		1/1	93/0		11/16	3/0
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1969 m = male f = female

	N26			N27			N28			N29		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY	5/7		55/7			48/4			142/13		6/6	104/6
JUN				11/11	7/4	169/0		2/2	79/8	29/31	31/41	621/106
JUL	2/2		137/0	6/8	5/4	66/4	5/8	17/19	190/29	25/27	57/60	637/79
AUG	5/8	33/64	596/17						69/2	4/3		185/25
SEP	5/4	4/5	48/0									
OCT												
NOV												
DEC												

	M22			M23			M24			M25		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG									13/1		15/13	67/15
SEP			47/4					10/12	258/40		24/26	194/90
OCT			20/0			46/0		24/30	65/7		19/28	102/44
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1969 m = male f = female

	M26			M27			~~M28~~ M29			~~M29~~ N30		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY										21/9	4/5	97/17
JUN										3/8	3/3	202/36
JUL										10/27	7/9	110/23
AUG		6/8	132/13		4/13	53/4			17/2			66/4
SEP		3/6	38/12									
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	P23NP			P23BS P28			P24NP			P24BS		
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL					5/6	48/5						
AUG												
SEP												
OCT	12/16		50/0				4/7		21/0	2/5		18/0
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1969 m = male f = female

	P25NP			P25BS			P26NP			P29		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN										0/3	8/15	28/2
JUL										2/3	7/4	84/9
AUG	4/6	7/11	87/0				6/8		3/0			
SEP	22/23	4/6	53/0	21/14		7/0	34/47	12/10	80/0			
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG												
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1968 m = male f = female

	M21			N21			N210S			N22		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR										17/9	15/15	252/16
MAY												20/0
JUN												
JUL												
AUG												
SEP			43/8	9/6	12/18	306/25			46/8	21/30	5/7	201/14
OCT	3/2		79/24	21/30	16/18	348/37					50/2	
NOV			9/0			123/14					66/4	
DEC												

	N220S			N23			N24			N25		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR				5/8	5/6	49/11						
MAY				15/8	31/40	51/2	19/14	47/47	69/1	9/7	6/2	39/6
JUN												
JUL										0/1	4/2	104/0
AUG				2/2		32/0	4/9	24/32	119/8	1/1	5/6	194/0
SEP				11/16	0/2	132/6	13/16		91/3	11/10	10/13	162/0
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1968 m = male f = female

	N26			N27			N28			N29		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY	13/6	20/10	108/14	8/10	17/22	211/15		13/17	127/0	3/0	20/10	197/0
JUN	11/10	4/4	22/0	14/12	7/11	48/1	5/4	7/5	113/0	21/23	29/26	725/29
JUL	3/7	4/4	149/0			182/8	1/9	6/13	328/19	24/41	49/61	744/42
AUG			74/5	7/12	6/2	154/4		0/3	307/18	21/19	33/48	406/21
SEP												
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	M22			M23			M24			M25		
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG				3/5	18/16	45/0			280/29			89/10
SEP												
OCT		8/7	18/0		6/4	177/19			118/16			
NOV	0/3		16/0									
DEC												

RAW WHALING CATCH DATA RUSSIAN 1968 m = male f = female

	P22			P21			N30					
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY									24/0			
JUN							35/42	4/5	331/11			
JUL							108/149	21/18	245/23			
AUG							3/5	5/4	15/0			
SEP	0/1	5/5	150/2	9/20		130/3						
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	M22			~~M23~~			~~M24~~			~~M25~~		
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG												
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1968 m = male f = female

	P23NP			P24NP			P24BS			P28		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY					2/0	17/0						
JUN											13/11	48/0
JUL												
AUG												
SEP	9/15	5/2	121/0				3/1		27/0			
OCT												
NOV												
DEC												

	P25NP			P25BS			P26NP					
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY								10/9				
JUN												
JUL												
AUG			30/0				12/24	38/1				
SEP						106/0						
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1967 m = male f = female

	N220S			N23			N24			N25		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR	7/7	4/9	42/3	1/3	3/6	9/1	1/2	4/1	58/1			
MAY				2/0	11/5	0/3	6/7	6/1	134/7		15/33	256/7
JUN										8/15	12/18	
JUL										13/23	39/42	139/0
AUG					4/13	66/0				3/2	62/73	365/31
SEP	16/27		93/1	0/2	5/2	127/4	2/1	9/18	100/7	7/10	2/3	72/5
OCT		3/4	62/10									
NOV												
DEC												

	N26			N27			N28			N29		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY	2/12	23/26	96/5	2/4	3/9	94/3	1/1		93/8	0/1	5/11	78/1
JUN						157/0	2/7	15/26	685/46	18/36	59/71	861/55
JUL	15/21	53/57	414/0			109/0	12/12	25/36	88/2	44/68	122/89	275/16
AUG	3/5	3/13	320/8	17/11	16/44	45/8	0/12	24/40	3/0			
SEP			73/9									
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1967 m = male f = female

	N21			N210S			N22			N30		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN										3/5		13/4
JUL												
AUG												
SEP			19/2	17/49	30/42	253/0	5/17	10/29	555/31			
OCT	4/10	30/67	440/27		2/0	16/0	0/1	11/18	850/93			
NOV												
DEC												

	P23NP			P23BS			P24NP			P24BS		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY								5/5	193/3			17/2
JUN												
JUL	8/0	5/0	13/0						4/0			
AUG	0/3	17/8	89/5								4/0	9/0
SEP	4/6		6/0									
OCT	0/13		28/1	0/17		66/5				15/18		28/0
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1967 m = male f = female

	P25NP			P25BS			P26NP			P26BS		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY		4/9	78/0				1/2	5/4	5/0			
JUN	22/26	21/13	54/0				0/3	0/8	34/3			
JUL	15/17	44/67	3/0			9/0	8/19	30/45	132/9	5/6		1/1
AUG				3/8	7/7	84/2	3/5			16/27	22/26	
SEP				7/12	0/1							
OCT												
NOV												
DEC												

	P27			P28			P29			Q25		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY	3/0	5/3	5/0									
JUN				3/5	10/7	355/7	23/34	16/42	278/5			
JUL		6/4	11/0					108/3				
AUG										21/14		25/0
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1967 m = male f = female

	M25			M26			M27			P21		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN										3/5		13/4
JUL												
AUG			18/0			83/1			82/1	54/92	33/26	7/0
SEP										7/15	34/34	
OCT												
NOV												
DEC												

	P22											
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG												
SEP	23/24		12/0									
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1966 m = male f = female

	P23NP			P23BS			P24NP			P24BS		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY								1/0	130/20			
JUN												
JUL			74/0		9/10	16/0		9/8	108/1			36/0
AUG												
SEP												
OCT	1/0	1/0	110/9	43/43	19/10	185/6	0/1	0/1	6/0	1/0		87/3
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	P25NP			P25BS			P26NP			P26BS		
JAN												
FEB												
MAR												
APR												
MAY		0/3	14/0									
JUN							3/0	6/12	87/0			
JUL	1/0	1/1		29/37	3/1	51/0	1/3	19/18	28/4	58/54		40/3
AUG		0/3	13/0									
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1966 m = male f = female

	N22			N23			N24			N25		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR	9/7	4/5	13/7	10/21	4/1	39/14	14/10	21/11	151/15			
MAY				7/10	14/19	62/7	27.53	43/40	154/14	7/11	23/48	153/16
JUN										1/0		58/2
JUL					5/15		45/78	63/82	101/4	5/10	24/32	159/4
AUG				10/4	10/7	7/0	19/23	59/122	130/2	35/47	12/21	309/19
SEP	0/1	3/4	388/4	4/1	2/7	17/4	0/1	1/2	68/1			
OCT	0/1	0/2	521/12		1/3	37/2				18/37	7/11	122/0
NOV	0/1	0/1	324/15									
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N26			N27			N28			N29		
JAN												
FEB												
MAR												
APR												
MAY	1/1	3/2	57/8		12/17	23/4	5/0		54/0	33/39	13/19	309/43
JUN	2/0	2/0	53/0			25/0	57/42	33/41	436/25	20/42	36/44	415/21
JUL	3/6	3/13	305/3	5/1	6/20	74/0	0/1		41/1		13/18	239/11
AUG	22/18	30/48	279/9	1/0	0/2	26/0						
SEP	2/4	4/8	195/13	2/0	14/18	205/2						
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1966 m = male f = female

	~~N22~~M30			P27			P28			P29		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY	4/5	0/3	8/2									
JUN				1/3		170/4	25/30	23/25	442/8	4/3	7/19	175/6
JUL				1/1	2/1	61/2		21/31	8/0			
AUG												
SEP												
OCT												
NOV												
DEC												

	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
	N30											
JAN												
FEB												
MAR												
APR												
MAY	16/21	2/2	52/6									
JUN												
JUL												
AUG												
SEP												
OCT												
NOV												
DEC												

RAW WHALING CATCH DATA RUSSIAN 1966 m = male f = female

	M22			M23			M24			M25		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR	8/8	8/2	12/2									
MAY												
JUN												
JUL												
AUG					7/3	98/4		7/8	341/8	40/37	19/21	285/30
SEP					0/1	2/0	1/0	4/2	181/13		1/7	47/0
OCT						28/4			4/1			
NOV												
DEC												

	M26			M27			M28			M29		
	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
JAN												
FEB												
MAR												
APR												
MAY												
JUN												
JUL												
AUG	5/16	13/9	81/4									
SEP		2/0	74/8			80/19	0/1		134/3			15/0
OCT			25/0									
NOV												
DEC												

JAPANESE EFFORT EXPRESSED AS $\frac{\text{CATCHER DAYS} \times \text{VESSEL TONNAGE}}{1000}$ 1970

BALEEN

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21					155	147	127	120	118	60	11	18
M22												
M23												
M24												
M25												
M26												
M27												
M28												
M29												
M30												
N21NP						7	46	51	43	44	34	4
N21OS						11	12	10	5	44		
N22NP												
N22OS												
N23					97	59	101	34				
N24					85	150	28	28				
N25					53	57	6	19	12			
N26					98	144	26	92	59			
N27					6	18	12	38	6			
N28						70	50	63				
N29						19	118	38				
N30												
P23NP							6	11				
P23BS								22				
P24NP						6	6	17				
P24BS							28	33				
P25NP						13						
P25BS								37				
P26NP						7	13					
P26BS								49				
P27							25					
P28							88					
P29							51	32				

JAPANESE EFFORT EXPRESSED AS $\dfrac{\text{CATCHER DAYS x VESSEL TONNAGE}}{1000}$ 1970

SPERM

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21												
M22												
M23												
M24												
M25												
M26												
M27												
M28												
M29												
M30												
N21NP												
N21OS												
N22NP												
N22OS												
N23					11	11	10	34				
N24					6	25	6	22				
N25						18	6	19	13			
N26					18	63	6	81	56			
N27							12	38	6			
N28							19	57				
N29							12	38				
N30												
P23NP							6	11				
P23BS								5				
P24NP												
P24BS							28	17				
P25NP						6						
P25BS												
P26NP					6							
P26BS												
P27							13					
P28							19					
P29							32	32				

JAPANESE EFFORT EXPRESSED AS $\frac{\text{CATCHER DAYS x VESSEL TONNAGE}}{1000}$ 1969

BALEEN

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21					177	188	149	12	12	102	59	38
M22												
M23												
M24												
M25												
M26												
M27												
M28												
M29												
M30												
N21NP					1	3	5	65	65	56	10	11
N21OS												
N22NP												
N22OS								12	12			
N23					157	188	108					
N24					148	161	30					
N25					19	75	106					
N26					31	106	30					
N27						6	58	23				
N28							100	24				
N29												
N30												
P23NP												
P23BS												
P24NP							6					
P24BS							6					
P25NP						12	36					
P25BS												
P26NP							43					
P26BS												
P27							19					
P28							13					
P29												

JAPANESE EFFORT EXPRESSED AS $\frac{\text{CATCHER DAYS x VESSEL TONNAGE}}{1000}$ 1969

SPERM

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21												
M22												
M23												
M24												
M25												
M26												
M27												
M28												
M29												
M30												
N21NP												
N21OS												
N22NP												
N22OS												
N23					67	12	72					
N24					80	72	30					
N25					12	19	36	6				
N26					19	25	18	6				
N27						6	12	41				
N28							24	51				
N29								102				
N30												
P23NP								38				
P23BS								6				
P24NP							6	6				
P24BS							13	25				
P25NP							6	25	25			
P25BS									6			
P26NP								31	50			
P26BS												
P27								6	24			
P28								12	41	7		
P29									19			

JAPANESE EFFORT EXPRESSED AS $\frac{\text{CATCHER DAYS x VESSEL TONNAGE}}{1000}$ 1968

BALEEN

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21					182	180	151	156	106	77	45	49
M22												
M23												
M24												
M25												
M26												
M27												
M28												
M29												
M30												
N21NP						8	30	36	70	76	53	13
N21OS					6							
N22NP												
N22OS												
N23					96	210	138					
N24					107	170	51					
N25					9							
N26								9				
N27								51				
N28								43				
N29												
N30												
P23NP						38	6					
P23BS												
P24NP						6	34					
P24BS						12						
P25NP							17					
P25BS							17	60				
P26NP							9	26				
P26BS												
P27								34				
P28								26				
P29												

JAPANESE EFFORT EXPRESSED AS $\frac{\text{CATCHER DAYS x VESSEL TONNAGE}}{1000}$ 1968

SPERM

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21												
M22												
M23												
M24												
M25												
M26												
M27												
M28												
M29												
M30												
N21NP												
N21OS												
N22NP												
N22OS												
N23					29	53	12					
N24					23	57	12	11				
N25						51	35					
N26						6	115	17				
N27							64	12				
N28							12	24				
N29							6	18				
N30												
P23NP						6						
P23BS												
P24NP						29		6				
P24BS					23	35	6					
P25NP					6	11	11					
P25BS						6	6					
P26NP							6					
P26BS												
P27							17	46				
P28												
P29												

JAPANESE EFFORT EXPRESSED AS $\frac{\text{CATCHER DAYS x VESSEL TONNAGE}}{1000}$ 1967

BALEEN

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21					75	92	70	119	85	86	126	68
M22												
M23												
M24												
M25												
M26												
M27												
M28												
M29												
M30												
N21NP					1	7	31	32	73	79	21	
N21OS												
N22NP							12					
N22OS												
N23					26			60				
N24					113	84		77				
N25					44	84		34				
N26						32						
N27												
N28												
N29												
N30												
P23NP							208					
P23BS							101					
P24NP						58	38					
P24BS							61					
P25NP					6	6	12					
P25BS							6					
P26NP						93						
P26BS												
P27						47						
P28						29						
P29												

JAPANESE EFFORT EXPRESSED AS $\frac{\text{CATCHER DAYS x VESSEL TONNAGE}}{1000}$ 1967

SPERM

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21												
M22												
M23												
M24												
M25												
M26												
M27												
M28												
M29												
M30												
N21NP												
N21OS												
N22NP							6					
N22OS												
N23					11							
N24					30	6	11					
N25					12	23	38	38				
N26						24	22	108				
N27								47				
N28												
N29												
N30												
P23NP							29					
P23BS							33					
P24NP					22	23	6					
P24BS					16	22	50					
P25NP					17	16	11					
P25BS					22	33	27					
P26NP						34						
P26BS												
P27						45						
P28						44						
P29												

JAPANESE EFFORT EXPRESSED AS $\frac{\text{CATCHER DAYS x VESSEL TONNAGE}}{1000}$ 1966

No separate effort data for sperm whaling in 1966.

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21					101	106	102	111	112	98	96	40
M22												
M23												
M24												
M25												
M26												
M27												
M28												
M29												
M30												
N21NP					9	12	30	43	61	65	31	
N21OS							7	38				
N22NP												
N22OS												
N23					26				18			
N24					15				15			
N25					7	11	42	26				
N26						25	7	20				
N27												
N28												
N29												
N30												
P23NP					11			19	15			
P23BS							11	29				
P24NP					25	20	26	18				
P24BS					11	37	133	102	13			
P25NP					17	20	133	40	7			
P25BS					11	63	63	126				
P26NP					37	74	33	37				
P26BS						16	11					
P27					15	43	35	22				
P28						292	95	105				
P29						7						

RUSSIAN EFFORT IN CATCHER DAYS 1970 ALL CATCHERS 843 TONS												
SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21										240	30	
M22										105		
M23									45	105		
M24								15	240	30		
M25							75	30	390	15		
M26							180		150			
M27							90					
M28						15	225					
M29						30						
M30						330						
N21NP										105	45	
N210S												
N22NP										45	30	
N220S												
N23					80				15	165		
N24					60			135	75	15		
N25					60		105	420	90			
N26					40	90	45	180	15			
N27					20		45	15				
N28					40		45					
N29					140	180						

RUSSIAN EFFORT IN CATCHER DAYS 1970 ALL CATCHERS 843 TONS

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N30					180	270						
P23NP												
P23BS												
P24NP												
P24BS												
P25NP												
P25BS												
P26NP												
P26BS												
P27												
P28												
P29												
Q25												

RUSSIAN EFFORT IN CATCHER DAYS 1969 ALL CATCHERS 843 TONS

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21									99	91	72	
M22									36	27		
M23										44		
M24								8	198	88		
M25								62	121	121		
M26								110	33			
M27								46				
M28												
M29								8				
M30												
N21NP									45	260	105	
N21OS										33	9	
N22NP					75				45	110	47	
N22OS										22		
N23				92	38				41	55		
N24					38			16		33		
N25					42		33	173	99	11		
N26					63		66	291	44			
N27					63	132	30					
N28					129	55	108	24				
N29					144	543	403	72				

RUSSIAN EFFORT IN CATCHER DAYS 1969 ALL CATCHERS 843 TONS

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N30					176	216	106	24				
P23NP										33		
P23BS												
P24NP										11		
P24BS										11		
P25NP								55	55			
P25BS									22			
P26NP								11	88			
P26BS												
P27												
P28							24					
P29						47	48					
Q25												

RUSSIAN EFFORT IN CATCHER DAYS 1968 ALL CATCHERS 843 TONS

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21									26	57	26	
M22										13	24	
M23								26		143		
M24								169		65		
M25								52				
M26												
M27												
M28												
M29												
M30												
N21NP									154	386	224	
N21OS									9	9	18	
N22NP				133	12				145	74	56	
N22OS												
N23				44	42			13	63	13		
N24					84	18		78	57	104		
N25					44		30	96	91	65		
N26					83	22	80	48				
N27					105	47	88	83				
N28					48	54	128	129				
N29					72	400	371	220				

RUSSIAN EFFORT IN CATCHER DAYS 1968 ALL CATCHERS 843 TONS

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N30					24	177	225	10				
P23NP									104			
P23BS												
P24NP					13							
P24BS									26			
P25NP								13				
P25BS									65			
P26NP					13			27				
P26BS												
P27												
P28						26						
P29												
Q25												

RUSSIAN EFFORT IN CATCHER DAYS 1967 ALL CATCHERS 843 TONS

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M21												
M22												
M23												
M24												
M25									8			
M26								36				
M27								32				
M28												
M29												
M30												
N21NP									20	300		
N210S									224	12		
N22NP								4	289	350		
N220S				56					95	34		
N23				16	41			60	60			
N24				8	81			8	78			
N25					131	20	120	241	51			
N26					107		207	194	40			
N27					85	40	47	49				
N28					52	236	101	24				
N29					54	277	279					

RUSSIAN EFFORT IN CATCHER DAYS 1967 ALL CATCHERS 843 TONS

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N30						8						
P23NP							8	64	9	40		
P23BS										58		
P24NP					68		8					
P24BS					24			24		19		
P25NP					36	76	80					
P25BS					24		8	18	18			
P26NP					22	24	71	9				
P26BS							27	72				
P27					9		9					
P28						174						
P29						126	48					
Q25								72				

RUSSIAN EFFORT IN CATCHER DAYS 1966 ALL CATCHERS 843 TONS

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N21												
N22				46								
N23								56	11	26		
N24								142	104	12		
N25								206	137	70		
N26								70	81	70		
N27									56			
N28									98			
N29									28			
N30									10			
N21NP										30		
N21OS				20					208	196	270	
N22NP				20					208	196	270	
N22OS												
N23				102	76		2	15	16	25		
N24				182	177		167	190	84			
N25					92	30	182	314		186		
N26					56	49	154	238	140			
N27					38	7	70	42	182			
N28					47	196	42					
N29					144	296	84					

RUSSIAN EFFORT IN CATCHER DAYS 1966 ALL CATCHERS 843 TONS

SQUARE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N30					48							
P23NP							24			80		
P23BS							18			153		
P24NP					82		18			23		
P24BS							49			75		
P25NP					5		8	6				
P25BS							126					
P26NP						37	52					
P26BS							131					
P27						33	84					
P28						183	92					
P29						130						
Q25												

LENGTH(ft)		M21			N21NP			N21OS					
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30												
46	31			1/1									
47	32			1/1									
48	33			2/6									
49	34			1/6									
50	35	1/0	1/4	277/821									
51	36		12/9	272/516		1/0	89/61						
52	37		4/7	178/208	1/0	2/0	61/22						
53	38		14/11	110/67		0/1	75/7	0/1					
54	39	0/3	17/19	72/21		4/4	45/3						
55	40	1/3	13/14	62/8	2/0	4/5	34/1						
56	41		25/21	42/3	1/2	2/2	30/0	1/1					
57	42		25/14	25/1	3/0	6/8	22/0						
58	43		33/32	16/0	2/0	8/8	39/0	2/1					
59	44	1/0	23/21	18/0	1/1	4/2	7/1	5/0					
60	45		16/29	15/0	0/3	5/7	9/0	2/0					
61	46	1/0	15/14	10/0	2/3	4/10	9/0	1/3					
62	47		8/10	6/0	2/5	2/7	10/0	2/2	3/1				
63	48		8/15	5/0	0/3	1/1	7/0	0/2					
64	49		1/4	3/0		0/1	5/0	0/2	0/3				
65	50		1/1	1/0	0/1		8/0	0/2					
66	51		0/5	4/0			2/0	0/2					
67	52				0/1		2/0	0/1					
68	53			2/0			3/0	0/4					
69	54			2/0									
70	55												
71	56												
72	57												
73	58												

Table title row: LENGTH FREQUENCY DISTRIBUTION OF THE CATCH JAPANESE 1970 m=male f=female

LENGTH (ft)		AREA II			AREA III			AREA IV			AREA V		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
53	33												
54	34												
55	35							1/0					
56	36			0/2	2/0		1/3			0/1			2/5
57	37	1/2		1/3	5/4		3/4	4/6		1/2	7/6		2/6
58	38	1/5		32/37	6/5	1/0	21/53	12/9	0/1	4/2	4/6		28/86
59	39	1/1		51/22	10/2		27/23	4/4	1/2	23/31	10/9	1/2	42/27
60	40	20/3	17/6	26/0	5/1	34/35	9/0	7/5	44/36	42/21	7/5	40/23	72/15
61	41	2/1	22/23	16/0	8/6	20/23	19/0	.13/5	40/37	78/5	11/9	35/22	54/4
62	42	3/1	27/11	16/0	5/3	16/13	17/0	11/4	32/29	54/0	15/8	46/36	71/5
63	43	7/1	40/23	14/0	3/3	37/26	30/0	6/4	43/32	55/0	19/5	57/41	68/0
64	44	2/1	66/17	7/0	5/5	28/21	15/0	4/2	44/44	57/0	14/5	76/38	60/0
65	45	5/1	84/29	6/0	5/6	43/14	21/0	5/7	70/36	55/0	12/8	111/31	45/0
66	46	2/2	75/29	3/0	2/5	31/23	30/0	3/6	61/28	49/0	9/7	133/49	52/0
67	47	1/2	39/35	2/0	0/1	18/20	35/0	1/6	60/40	50/0	3/10	63/61	44/0
68	48	1/0	17/33	7/0	1/5	10/17	53/0	0/5	27/54	79/0	1/9	49/92	22/0
69	49	0/3	8/31	8/0	2/5	4/13	67/0	0/3	13/51	102/0	1/4	17/66	32/0
70	50	0/2	2/26	18/0		0/11	54/0		3/36	128/0	0/3	3/45	26/0
71	51	0/1	1/3	5/0	0/1	0/4	41/0		0/31	89/0		1/29	17/0
72	52		0/3	4/0	0/1	0/4	38/0		0/11	84/0	0/1	0/16	19/0
73	53		0/1			0/1	11/0		0/3	27/0	0/1	0/4	3/0
74	54						2/0			5/0		0/1	
75	55									2/0			

Table title: LENGTH FREQUENCY DISTRIBUTION OF THE CATCH JAPANESE 1970 m=male f=female

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH Japanese 1969 m=male f=female

LENGTH(ft)		AREA II			AREA III			AREA IV			AREA V		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
53	33				1/1			1/1					0/1
54	34												0/2
55	35				0/1	0/1		9/5			22/12		0/3
56	36			2/6	1/0		0/1	6/8		1/0	16/9		0/14
57	37			1/1	1/0		1/0	10/3		1/1	6/5		2/3
58	38			66/141	2/0	1/1	37/40	5/3	3/4	7/21	12/4	2/1	141/221
59	39			102/134	3/2		46/40	12/7	0/1	25/1	21/7		124/97
60	40		2/1	74/65	1/1	88/63	22/0	8/4	39/25	22/0	26/9	70/42	71/26
61	41		1/1	38/38	4/2	63/45	35/12	19/3	50/41	22/2	17/10	59/41	55/8
62	42		2/0	38/34	2/0	28/27	21/4	12/7	33/30	18/0	19/6	61/37	40/0
63	43		2/2	35/28	1/6	32/28	1/6	12/10	54/33	29/0	15/14	118/41	35/1
64	44		2/0	14/6	2/2	37/19	14/0	6/9	49/22	37/0	13/11	178/28	24/0
65	45		7/0	10/5	2/5	44/47	20/0	5/12	62/30	26/0	2/17	223/43	12/0
66	46		3/1	13/2	0/1	37/39	28/0	3/13	70/41	34/0	0/14	133/53	12/0
67	47		3/1	6/0	0/1	22/65	39/0	0/6	56/36	42/0	0/13	161/69	15/0
68	48		1/0	4/0		6/67	64/0	0/4	36/54	46/0	0/12	56/87	18/0
69	49		0/2	2/0	0/1	3/46	46/0	0/4	11/52	59/0	0/3	18/84	23/0
70	50		0/1	3/0		0/31	29/0	0/5	2/26	50/0	0/6	5/55	33/0
71	51					0/17	20/0		0/16	29/0	0/2	0/38	22/0
72	52			1/0		0/6	8/0		0/3	30/0		0/10	15/0
73	53			2/0			1/0			0/3		0/3	3/0
74	54									0/2			
75	55												

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH JAPANESE 1969 m=male f=female

LENGTH(ft)		N210S			N21NP			M21					
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30						1/0			2/0			
46	31						0/1			0/1			
47	32									0/3			
48	33						0/1			2/8			
49	34						44/143			0/1			
50	35				0/1		116/111			214/643			
51	36				1/1		79/32		1/1	245/554			
52	37				2/1	2/1	87/12			182/182			
53	38					8/1	122/11			133/71			
54	39				1/1	4/2	34/3		3/5	126/24			
55	40				2/0	1/1	60/0	1/0	6/5	47/4			
56	41				4/0	11/1	23/0	0/2	14/6	55/2			
57	42				3/1	15/11	54/0		16/4	37/0			
58	43				1/2	11/8	14/0	0/1	15/18	33/0			
59	44	1/1	1/0		1/2	15/5	11/0		26/11	24/0			
60	45	1/0	0/1		3/4	9/8	11/0	1/2	19/23	8/0			
61	46	2/1	1/0		2/1	10/12	11/0	0/1	17/13	8/0			
62	47	0/2	0/1		0/1	1/13	10/0	1/1	14/13	14/0			
63	48	2/3	0/1		1/1	0/8	7/0		10/0	8/0			
64	49				1/2	0/3	2/0		4/15	10/0			
65	50	0/5			2/0	0/1	1/0	0/1	16/0	8/0			
66	51	0/1				0/2	3/0		1/5	4/0			
67	52				0/1				1/4	4/0			
68	53	0/1			0/1				0/1	3/0			
69	54	0/1								2/0			
70	55												
71	56												
72	57												
73	58												

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH JAPANESE 1968 m=male f=female

LENGTH(ft)		N210S			N21NP			M21					
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30									1/0			
46	31									3/6			
47	32									0/4			
48	33									1/1			
49	34									0/3			
50	35				0/1	0/1	120/393		3/3	318/1068			
51	36					1/1	140/195		6/7	182/570			
52	37				2/2	4/2	64/35	1/0	3/9	106/118			
53	38				0/4	4/3	35/16		9/6	55/46			
54	39				4/4	3/10	22/10	0/1	21/13	50/15			
55	40				1/0	7/3	8/1		12/10	21/1			
56	41				0/3	5/4	10/0	1/1	19/18	20/1			
57	42				1/2	10/7	2/0		36/24	15/0			
58	43				2/1	9/11	1/0		39/17	15/0			
59	44				1/0	15/12	5/0		40/29	6/0			
60	45				1/1	10/10	3/0	0/1	42/27	2/0			
61	46	1/0	1/0		0/2	9/13	3/0	2/0	32/18	8/0			
62	47	1/0	1/0		1/0	5/17	6/0	0/1	24/30	4/0			
63	48				0/1	4/9	4/0		16/21	3/0			
64	49				0/1	0/8	2/0		9/20	3/0			
65	50				0/1	0/7	5/0		2/18	3/0			
66	51				0/2	0/2	1/0		0/5	1/0			
67	52				0/2		2/0		0/4	1/0			
68	53				0/1					2/0			
69	54								0/1	1/0			
70	55												
71	56												
72	57												
73	58												

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH JAPANESE 1968 m=male f=female													
LENGTH(ft		AREA II			AREA III			AREA IV			AREA V		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
53	33												0/1
54	34											1/0	0/4
55	35				2/0			9/9			16/9		0/2
56	36				6/1		1/1	18/15			23/13	0/1	1/2
57	37				3/3		2/1	15/3	1/0		20/10	1/1	
58	38			15/31	2/3		90/97	8/7		16/18	24/10	1/2	139/313
59	39			9/16	5/1		74/27	11/4		18/0	20/8		107/37
60	40			6/9	4/0	15/12	67/16	19/4	5/5	28/0	30/10	81/64	107/9
61	41			10/1	2/2	27/19	59/2	8/4	9/8	33/0	26/13	112/97	90/4
62	42			7/1	3/1	19/15	58/0	15/3	6/7	44/0	37/18	99/49	72/2
63	43			3/0	5/2	41/15	40/0	7/8	14/6	42/0	19/26	182/63	55/1
64	44			1/0	1/2	47/9	39/0	0/5	19/6	53/0	10/30	269/72	37/0
65	45			1/0	2/3	54/17	33/0	0/5	22/7	53/0	9/19	303/93	21/0
66	46				1/4	70/22	42/0	0/4	17/8	77,0	1/30	339/153	29/0
67	47			2/0	0/1	44/13	33/0	0/3	8/3	87/0	0/19	214/158	28/0
68	48			3/0	0/1	24/23	62/0		6/1	98/0	0/7	96/181	20/0
69	49			3/0		9/23	63/0		1/5	119/0	0/8	37/153	38/0
70	50			3/0		1/10	38/0		0/5	88/0	0/5	3/116	19/0
71	51			1/0		1/5	19/0		0/1	39/0	0/1	1/65	20/0
72	52			1/0		0/1	7/0			28/0	0/1	1/32	10/0
73	53				0/1					3/0		0/9	4/0
74	54												
75	55												

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH JAPANESE 1968 m=male f=female

LENGTH(ft)		AREA VI											
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
53	33												
54	34												
55	35	1/0											
56	36												
57	37												
58	38												
59	39												
60	40	2/0											
61	41		0/2										
62	42	0/1	3/1										
63	43	1/1	3/0										
64	44		7/1										
65	45	0/1	8/1										
66	46	1/1	14/1										
67	47		5/3										
68	48	0/1	1/3										
69	49		1/5										
70	50	0/1	0/2										
71	51		0/2										
72	52												
73	53												
74	54												
75	55												

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH JAPANESE 1967 m=male f=female													
LENGTH(ft)		N21OS			N21NP			M21					
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30												
46	31									1/0			
47	32									2/0			
48	33									1/2			
49	34								1/2	189/521			
50	35	0/2					64/214	0/2	1/6	191/397			
51	36					1/3	171/167		1/1	78/80			
52	37				2/0	4/6	82/21		5/3	66/19			
53	38	1/0			2/4	5/3	19/1		5/13	69/7			
54	39				3/0	3/5	14/1		6/9	50/2			
55	40	0/1			1/0	5/10	7/1	0/1	6/10	53/0			
56	41	1/0			0/3	7/10	10/0		12/10	27/0			
57	42				0/2	16/13	4/0		18/7	35/0			
58	43	1/2			5/2	11/9	2/0		13/8	7/0			
59	44		1/0			23/19		1/0	13/7	6/0			
60	45	3/1	1/0		0/4	7/19	2/0	1/0	16/10	7/0			
61	46	4/0	1/1		0/2	12/32	4/0	0/1	3/5	7/0			
62	47	2/3	1/0		1/1	6/17	2/0	1/0	1/8	8/0			
63	48		0/1		0/2	1/11	3/0		2/6	8/0			
64	49	0/3	1/0		0/1	0/8	1/0		0/3	5/0			
65	50	2/3			0/1	0/4	1/0		0/1	2/0			
66	51	1/2	0/1		0/1	0/3	1/0	0/1		1/0			
67	52						1/0						
68	53												
69	54									1/0			
70	55												
71	56												
72	57												
73	58												

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH JAPANESE 1967 m=male f=female

LENGTH(ft)		AREAIII			AREA IV			AREA VI			AREA V		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
53	33							0/2			2/0		1/0
54	34	0/1		0/1			0/1				1/1		0/1
55	35			0/1	3/3	0/1	1/2	7/5			25/18		1/5
56	36	1/1		0/6	2/3			7/3			26/31		0/1
57	37	3/1		0/2	1/3			4/1			26/16	1/0	
58	38	1/1		92/123	2/0		41/19	2/3			28/19		130/131
59	39	1/0		67/24	2/1	1/0	58/7	3/2		1/0	33/21	0/1	84/2
60	40	1/1	2/1	49/4	9/2	11/12	87/4	4/1	1/0	3/0	60/17	36/36	73/0
61	41	3/0	3/0	47/0	4/1	31/18	102/0	1/3		1/0	42/20	84/57	59/0
62	42	2/2	2/1	45/0	8.4	21/20	80/0	1/2		2/0	33/18	71/46	47/0
63	43	1/1	4/1	37/0	3/2	68/20	106/0	2/3		1/0	23/40	145/63	45/0
64	44	1/3	9/0	33/0	4/6	93/24	93/0	2/4			10/22	201/74	30/0
65	45	2/2	8/0	25/0	2/2	129/49	88/0	0/4			5/30	302/69	18/0
66	46	2/2	7/2	33/0	0/7	149/49	108/0	0/2			4/40	285/98	21/0
67	47		2/3	30/0	0/2	82/63	136/0				1/18	159/121	34/0
68	48		2/3	31/0	0/3	51/57	172/0			1/0	0/13	85/125	17/0
69	49	0/1	0/1	32/0	0/3	19/64	162/0				0/5	17/110	22/0
70	50		0/1	24/0	0/1	6/35	123/0				0/6	9/73	34/0
71	51			8/0		0/14	65/0	0/1	0/2		0/1	2/40	9/0
72	52			6/0		0/13	29/0				0/1	0/9	6/0
73	53			2/0		0/2	3/0					0/1	5/0
74	54											0/1	
75	55						1/0						

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH JAPANESE 1966 m=male f=female

LENGTH(ft)		AREA III			AREA IV			AREA V			AREA VI		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
53	33	5/1	0/1		1/1	0/2	11/0		0/1	7/0	1/2		
54	34	1/2					3/0			2/0	1/0		
55	35	75/73			36/50			5/6			1/1		
56	36	35/26			10/10			7/7			2/1		
57	37	22/21			12/14			8/3			3/2		
58	38				19/15			12/12			2/1		
59	39	26/16			11/7			11/4			8/2		
60	40	34/26			14/12			13/7			3/4		
61	41	40/9			19/14			6/3			5/3		
62	42	40/12			14/8			10/7			6/1		
63	43	34/24			6/6			9/7			3/3		
64	44	20/23			8/10			3/7			2/5		
65	45	6/33			10/5			3/13			0/5		
66	46	6/32			3/8			2/4			1/4		
67	47	2/29			1/9			0/8			0/3		
68	48	0/14			1/5			0/3			0/2		
69	49	0/13			0/3			0/2			0/2		
70	50	0/7			0/2			0/3					
71	51	0/1											
72	52	0/1											
73	53	0/3						0/1					
74	54	0/2											
75	55												

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH JAPANESE 1966 m=male f=female

LENGTH(ft)		AREA III			AREA IV			AREA V			AREA VI		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
30													0/3
31													1/1
32													0/5
33												1/0	2/2
34							1/0						0/4
35												0/7	91/495
36							0/6			2/0		1/3	175/431
37							2/5					3/5	152/110
38			1/0	11/18		1/0	23/6			52/38		2/7	110/37
39							9/18			48/7			111/10
40			36/33	15/3		43/38	83/0		3/5	140/9		4/0	75/5
41			22/26	2/1		30/25	83/0		9/1	129/4		11/4	68/2
42			30/15	1/0		30/17	95/0		5/7	100/1		11/8	46/0
43			49/24	13/0		44/24	142/0		12/1	111/1		6/10	51/0
44			81/18	5/0		68/20	130/0		10/2	64/0		14/9	28/0
45			114/36	5/0		82/23	88/0		9/10	56/0		11/18	10/0
46			119/41	3/0		98/46	102/0		24/11	63/0		11/16	6/0
47			113/40	7/0		74/57	106/0		21/10	55/0			5/0
48			47/47	3/0		48/42	128/0		11/12	54/0		5/15	20/0
49			30/53	3/0		21/48	127/0		8/15	64/0		3/19	18/0
50			4/27	2/0		4/36	154/0		1/15	65/0	3/2	2/4	14/0
51			0/21	2/0		0/18	80/0		1/4	39/0	4/3	0/4	10/0
52		1/2	1/7	1/0	1/1	0/8	100/0		1/7	35/0	6/2	0/1	2/0

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH RUSSIAN 1970 m=male f=female													
LENGTH(ft)		Area VI			Area V			Area IV			Area III		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30			1/1			0/1			0/1			
46	31			2/4			0/2			1/0			0/1
47	32			1/4			2/2			0/1			
48	33			2/6			1/5			2/0			0/1
49	34			0/8			2/5			1/1			1/4
50	35			1/9			3/5			1/1			1/1
51	36			1/4			5/9			0/10			1/8
52	37			0/11			6/24		1/1	9/12		0/1	0/25
53	38			88/135			117/85		1/0	115/109			43/55
54	39	0/1		98/112			117/94	1/1	2/0	223/125	1/0	0/1	68/32
55	40	0/3		111/1	1/1	0/2	185/20	1/6	0/13	281/20	0/2	4/1	103/1
56	41	2/3	2/1	109/1	2/2	7/2	215/0	5/4	13/16	337/3	1/0	3/4	130/0
57	42	0/6	5/2	65/0	1/2	6/5	168/0	5/6	10/36	363/0	2/2	8/3	99/0
58	43	3/3	5/5	64/0	3/1	7/6	139/0	5/5	14/20	286/0	5/2	6/10	55/0
59	44	1/4	6/9	53/0	1/3	0/9	143/0	8/7	10/19	237/0	0/2	1/3	39/0
60	45	4/7	7/15	22/0	1/2	2/6	95/0	8/10	23/17	229/0		3/6	17/0
61	46	1/1	2/0	76/0		2/2	82/0	4/4	8/9	143/0	0/1	1/1	23/0
62	47	3/1	3/2	16/0	0/1	2/0	66/0	4/4	10/14	130/0		1/3	11/0
63	48	4/1	1/1	15/0	1/0	3/0	59/0	2/0	6/0	165/0		1/1	13/0
64	49	2/3	1/0	0/4	0/1	2/1	28/0	3/2	8/12	170/0	1/0	0/2	23/0
65	50	3/0		4/0	0/2	3/1	23/0	1/6	3/8	142/0			16/0
66	51		1/0	2/0	3/1	1/2	13/0	2/2	2/5	106/0			12/0
67	52		0/1	7/0		3/0	12/0	0/3	3/4	64/0	0/1	0/1	17/0
68	53	2/0		4/0		0/2	8/0	1/3	2/2	50/0			3/0
69	54					1/0		0/1	0/4	9/0		1/0	
70	55												
71	56												
72	57							0/1					
73	58												

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH RUSSIAN 1970 m=male f=female

LENGTH(ft)		Area II											
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30			3/0									
46	31			2/0									
47	32			2/0									
48	33			1/4									
49	34			0/10									
50	35			2/8									
51	36	0/1		4/21									
52	37			6/31									
53	38			98/179									
54	39			128/158									
55	40	3/2	9/6	214/1									
56	41	4/5	11/13	192/2									
57	42	9/7	11/13	185/0									
58	43	10/19	8/24	143/0									
59	44	13/12	18/23	96/0									
60	45	8/11	15/24	82/0									
61	46	8/7	7/12	48/0									
62	47	8/7	3/5	36/0									
63	48	4/9	5/17	29/0									
64	49	3/0	3/7	17/0									
65	50	7/6	5/3	27/0									
66	51	4/2	2/5	7/0									
67	52	1/2	2/2	9/0									
68	53	7/5	1/1	6/0									
69	54	4/4	1/3										
70	55	2/5	1/0										
71	56	1/2	0/1										
72	57	1/2											
73	58	0/2											

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH RUSSIAN 1969 m=male f=female

LENGTH(ft)		Area II			Area III			Area IV			Area V		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30						1/0			1/6			
46	31	1/1					1/0			3/3			
47	32			1/0						2/5			2/0
48	33			6/0			2/0			1/3			0/4
49	34			1/3			1/2			1/9			1/2
50	35			5/7			2/2			3/8			0/2
51	36						6/4			6/4			4/4
52	37		1/0	5/15			1/7			9/13			6/5
53	38			6/24			37/27			123/76			68/24
54	39			105/117	0/1	0/1	117/24	1/0	1/0	190/60			112/16
55	40		5/2	317/140	2/0	3/3	80/2	2/9	12/16	275/3	0/3	7/7	108/3
56	41	6/7	13/13	319/2	0/2	4/5	123/0	14/10	20/20	283/3	3/5	7/6	134/0
57	42	6/8	19/8	282/6	3/3	12/4	114/0	14/10	22/26	247/0	4/1	11/12	125/0
58	43	15/10	18/15	283/0	3/2	10/6	87/0	14/11	29/20	192/0	3/1	14/10	76/0
59	44	8/7	22/15	225/0	5/5	11/5	50/0	23/17	36/35	155/0	7/4	3/12	66/0
60	45	25/10	17/14	120/0	0/6	4/1	52/0	17/26	12/41	140/0	0/3	8/10	61/0
61	46	8/7	5/11	78/0	3/0	2/7	56/0	6/15	14/24	103/0	2/7	3/10	33/0
62	47	8/9	8/21	105/0	2/3	2/5	37/0	3/4	12/19	108/0	1/0	0/8	46/0
63	48	2/11	1/9	73/0	1/0	0/3	27/0	7/3	9/25	117/0	0/3	1/2	45/0
64	49	5/8	4/10	51/0	0/1	0/6	25/0	1/0	8/8	120/0	0/1	0/7	27/0
65	50	1/13	3/3	60/0	0/1	1/0	25/0	4/6	6/14	122/0	0/1	1/5	14/0
66	51	3/5	4/9	50/0	1/0	0/2	9/0	3/1	1/3	76/0		1/2	18/0
67	52	1/8	2/2	31/0			3/0	1/3	0/4	51/0			13/0
68	53	3/4	4/2	18/0	2/0		3/0	3/1	2/0	24/0			2/0
69	54	1/0	1/5	9/0				2/8	3/0	3/0		1/0	
70	55	1/2	0/2	2/0	0/2			0/2					
71	56		0/1					1/2			1/0		
72	57	0/1	0/1					1/5					
73	58												

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH RUSSIAN 1969 m=male f=female

LENGTH(ft)		Area VI											
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30			0/2									
46	31			0/2									
47	32			1/2									
48	33			0/4									
49	34			0/2									
50	35			0/6									
51	36			1/16									
52	37			2/13									
53	38			76/35									
54	39			180/50									
55	40		4/3	124/0									
56	41	1/0	7/6	191/0									
57	42	3/3	8/4	133/0									
58	43	2/1	13/8	101/0									
59	44	3/2	11/6	74/0									
60	45	2/5	6/11	44/0									
61	46		2/14	46/0									
62	47	2/3	3/5	43/0									
63	48		3/8	22/0									
64	49	0/2	3/7	27/0									
65	50	1/0	1/4	19/0									
66	51		3/2	8/0									
67	52			3/0									
68	53	1/0		1/0									
69	54	0/1	1/0										
70	55												
71	56												
72	57	0/1											
73	58												

RUSSIAN 1968

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH m=male f=female

LENGTH(ft)		Area II			Area III			Area IV			Area V		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30	0/1		0/1			1/0						
46	31												
47	32												
48	33			13/1			2/3						
49	34			2/0									1/4
50	35			8/4			1/2			1/2			2/4
51	36	0/17		27/10			11/2			2/2			11/17
52	37		1/0	15/14			2/5			0/2		2/1	30/13
53	38		1/1	198/46			105/21			62/15			132/50
54	39		5/10	412/48		1/0	186/31	2/1		162/14			305/12
55	40		11/10	452/2	0/3	4/3	218/0	3/4	3/6	201/1	2/2	4/2	252/2
56	41	9/5	11/10	438/0	2/3	11/2	234/0	3/6	9/4	220/0	3/4	17/6	302/1
57	42	35/17	35/12	288/0	8/5	16/2	163/0	13/3	19/16	18/0	19/5	17/7	176/0
58	43	31/21	38/23	239/0	11/2	9/9	132/0	7/0	22/18	103/0	8/5	36/25	144/0
59	44	76/66	19/20	172/0	12/2	14/11	121/0	21/8	17/18	117/0	35/27	40/19	116/0
60	45	20/31	11/24	99/0	3/4	4/11	69/0	3/9	9/15	46/0	4/17	10/54	48/0
61	46	11/20	8/22	85/0	3/2	3/13	61/0	2/10	8/15	40/0	2/6	13/6	28/0
62	47	10/22	3/13	74/0	0/3	1/11	59/0	0/6	4/3	36/0	3/4	6/10	27/0
63	48	1/17	4/11	65/0	0/3	4/10	49/0	3/4	4/2	23/0	1/5	3/11	25/0
64	49	1/18	3/7	65/0	0/3	1/4	45/0	0/6		22/0	2/5	0/6	20/0
65	50	7/7	5/5	57/0	0/3	0/2	40/0	1/3	2/0	18/0	2/3	4/1	16/0
66	51	0/8	1/2	31/0	0/7	1/2	19/0	0/7	1/0	11/0	1/5		13/0
67	52	0/2	2/0	0/19	1/2		7/0	1/2		7/0			18/0
68	53	4/6	1/1	9/0		0/3	1/0			3/0	0/1		7/0
69	54	2/5	2/1	1/3	0/2								
70	55	1/13			0/1							0/1	2/0
71	56	3/8			2/1			2/1			6/3		
72	57												
73	58												

RUSSIAN 1968

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH													m=male f=female
LENGTH(ft)		Area VI											
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30			0/1									
46	31			0/1									
47	32			0/4									
48	33			1/5									
49	34			2/3									
50	35			5/9									
51	36			6/17									
52	37			11/18									
53	38			134/59									
54	39			276/48									
55	40	2/11	5/4	186/0									
56	41	6/14	9/4	277/0									
57	42	26/7	9/1	225/0									
58	43	8/7	14/6	179/0									
59	44	25/10	9/9	143/0									
60	45	7/18	5/6	75/0									
61	46	2/11	5/16	70/0									
62	47	2/7	2/4	78/0									
63	48	0/3	3/3	64/0									
64	49	0/6	0/6	59/0									
65	50	1/3		41/0									
66	51	0/1	0/1	17/0									
67	52	0/1	0/2	23/0									
68	53			12/0									
69	54			5/0									
70	55												
71	56	1/1											
72	57												
73	58												

RUSSIAN 1967

LENGTH (ft)		Area II			Area III			Area IV			Area V		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30			1/3						1/1			1/0
46	31									2/2			
47	32									1/2			2/0
48	33			2/0						1/0			6/0
49	34			2/0			2/1		1/0	11/3			
50	35			0/4			2/5		0/1	31/2			
51	36			4/1			10/3	1/0	1/0	8/10		0/1	3/3
52	37	0/1	1/0	7/10		0/1	10/8	1/0	1/1	135/38			1/3
53	38			81/46	0/1		65/37	1/1		269/19	0/1		52/10
54	39		1/0	176/20			193/21	1/0	22/29	225/3		3/1	162/20
55	40	6/5	13/4	208/1	1/0	10/16	211/1	13/5	35/26	170/0	3/5	8/0	128/2
56	41	9/5	29/10	217/0	4/2	8/5	203/0	25/23	30/35	195/2	5/13	8/3	98/0
57	42	20/3	45/16	203/0	4/2	18/10	247/1	19/18	42/40	188/0	3/3	1/2	104/0
58	43	4/5	41/17	180/0	3/1	20/15	167/0	17/19	25/22	139/0	10/4	8/2	91/0
59	44	20/6	13/20	140/0	11/1	20/14	130/0	16/25	20/17	97/0	4/8	9/3	53/0
60	45	9/11	8/16	102/0	6/2	4/16	114/0	20/21	20/32	146/0	4/6	11/2	51/0
61	46	7/16	20/31	78/0	3/8	7/33	100/0	17/22	14/25	130/0	3/6	7/7	61/0
62	47	6/18	7/22	45/0	2/7	6/19	50/0	8/24	23/27	114/0.	1/2	4/5	55/0
63	48	3/12	8/22	39/0	1/8	1/10	59/0	2/17			1/1	9/6	39/0
64	49	0/22	3/25	59/0	2/1	1/9	65/00	31/10	20/28	162/0	1/7	.9/10	32/0
65	50	1/9	1/12	29/0	0/4	2/7	27/0	3/9	20/30	96/0	1/5	1/1	34/0
66	51	0/15	4/4	30/0	1/4	2/7	32/0	2/19	30/33	66/0	1/7		11/0
67	52	1/3	2/3	3/0	0/3	0/2	15/0	0/3	27/74	44/0	0/3	1/3	9/0
68	53		6/8	5/0	0/1	2/4	4/0	0/4	6/13	19/0		0/9	11/0
69	54	1/3		2/1	2/3	1/1	1/0	0/2	1/2	3/0	0/1	1/1	2/0
70	55	0/3	0/1	1/1	0/1	2/0		1/0	3/5				
71	56	0/2			1/1				1/2				
72	57	0/4			1/0				0/1				
73	58								0/2				

Table title: LENGTH FREQUENCY DISTRIBUTION OF THE CATCH — m=male f=female

RUSSIAN 1967

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH m=male f=female

LENGTH(ft)		Area VI											
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30			0/2									
46	31			1/1									
47	32			2/1									
48	33			2/3									
49	34			4/5									
50	35	0/1		10/8									
51	36	1/4		23/16									
52	37	1/3	1/0	18/18									
53	38	3/3	0/1	147/63									
54	39			335/40									
55	40	2/4	2/10	269/7									
56	41	8/12	15/14	308/0									
57	42	13/17	10/21	244/1									
58	43	3/17	15/18	190/0									
59	44	18/19	8/20	155/0									
60	45	4/18	13/19	123/0									
61	46	6/22	14/15	114/0									
62	47	4/37	6/21	118/0									
63	48	5/21	8/19	122/0									
64	49	8/28	11/16	46/0									
65	50	3/13	13/17	25/0									
66	51	1/19	17/18	6/0									
67	52	1/5	6/10	10/0									
68	53	2/7		3/2									
69	54	1/5											
70	55	2/1	0/2										
71	56	0/3	1/1										
72	57	0/1	0/1										
73	58	0/1	1/0										

RUSSIAN 1966

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH													m=male f=female
LENGTH(ft)		Area II			Area III			Area IV			Area V		
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30			0/1						1/0			
46	31							0/1		0/2			
47	32									0/1			
48	33			1/1			2/1			0/3			1/1
49	34			1/5			1/1			2/1			1/1
50	35			2/4			3/0			0/4			2/4
51	36			4/5			3/1			3/4			4/7
52	37			7/8			13/3		1/1	11/3			8/15
53	38	0/1	0/1	133/45	1/0		122/36		1/0	155/65			349/67
54	39	1/0	2/0	277/25			304/21	2/1	1/0	403/40			588/31
55	40	17/17	9/10	240/5	24/11	10/13	249/3	25/26	19/26	289/2	9/6	28/32	286/6
56	41	11/20	11/14	144/0	17/18	23/19	253/1	24/30	37/39	288/1	21/13	46/22	138/1
57	42	9/6	4/6	104/0	12/9	2/6	149/1	33/30	4/9	234/1	25/6	65/13	235/0
58	43	4/6	7/17	102/0	6/6	10/14	173/0	22/20	19/29	199/0	22/4	46/33	115/0
59	44	5/14	11/10	33/0	6/8	5/8	84/0	24/36	7/20	159/0	42/21	21/51	96/0
60	45	5/6	5/2	38/0	4/4	5/6	79/0	15/12	12/13	116/0	16/12	12/32	72/0
61	46	6/7	7/12	29/0	4/4	12/11	69/0	20/26	28/25	129/0	16/25	29/64	63/0
62	47	5/6	1/4	26/0	6/7	12/6	83/0	25/30	7/5	105/0	7/32	6/26	36/0
63	48	2/3	4/12	28/0	3/3	11/18	60/0	3/6	15/32	84/0	8/22	11/31	28/0
64	49	4/7	5/6	20/0	3/7	6/13	41/0	9/23	11/20	127/0	4/27	7/16	102/0
65	50		0/4	8/0		3/11	60/0	2/4	2/7	60/0	3/20	2/15	30/0
66	51	4/7	5/2	11/0	1/4	4/12	21/0	11/12	4/7	45/0	4/20	0/10	36/0
67	52	0/2	1/1	4/0	3/1	0/1	11/0	5/5	0/4	15/0	2/12	0/3	18/0
68	53	0/1	2/3	1/0	0/1	1/8		1/4	4/12	9/0	0/3	4/9	4/0
69	54	0/2	2/0	1/0	1/0	5/2		4/8	0/1	1/0	1/10	2/4	1/0
70	55	0/1		1/0	1/0	1/2		0/2	0/1		1/3	1/0	
71	56	1/1	2/1					6/4	3/2		1/4		
72	57	2/1						1/1	1/0		0/5	0/1	
73	58	0/1						1/0	0/1				

RUSSIAN 1966

LENGTH FREQUENCY DISTRIBUTION OF THE CATCH m=male f=female

LENGTH(ft)		Area VI											
FIN	Others	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f	FIN m/f	SEI m/f	SPERM m/f
45	30												
46	31												
47	32												
48	33			0/1									
49	34												
50	35			3/1									
51	36			4/1									
52	37			1/9									
53	38			124/21									
54	39			256/8									
55	40			101/1									
56	41	1/1	3/0	134/0									
57	42	1/3	8/0	104/0									
58	43		3/3	94/0									
59	44	2/3	0/2	91/0									
60	45	1/1	0/1	53/0									
61	46	2/1	1/3	63/0									
62	47	2/3		105/0									
63	48	4/2	0/3	93/0									
64	49	1/1	0/2	15/0									
65	50	0/1		63/0									
66	51	2/0		16/0									
67	52	1/1	0/1	3/0									
68	53	0/1		3/0									
69	54												
70	55												
71	56												
72	57												
73	58												

```
C     PROGRAM WHLPOP
C
C     THIS PROGRAM COMPUTES POPULATION BY THE 'Q' METHOD FOR A FIVE YEAR SERIES
C     DECK SET-UP
C        1  YEARS IN SERIES
C        2  CATCH IN EACH YEAR
C        3  EFFORT IN EACH YEAR
C        4  PROPORTION OF THE SELECTED AGE GROUP IN EACH YEAR
C        5  PROPORTION OF THE SELECTED AGE GROUPS IN THE BASE YEAR
C
      DIMENSION Y(5),C(5),E(5),P(5),R(5),SE(5),D(5),G(5),F(5),POP(5)
 1000 READ(5,100,END=90)Y,C,E
      READ(5,200)P,R
      DO 10 I=1,5
      D(I)=C(I)/E(I)
   10 CONTINUE
      DO 20 I=1,5
      G(I)=D(1)/D(I)
   20 CONTINUE
      SE(1)=0
      SE(2)=(E(1)+E(2))/2
      SE(3)=(E(1)+2*E(2)+E(3))/2
      SE(4)=(E(1)+2*E(2)+2*E(3)+E(4))/2
      SE(5)=(E(1)+2*E(2)+2*E(3)+2*E(4)+E(5))/2
      TX=0
      DO 30 I=1,5
      TX=TX+SE(I)
   30 CONTINUE
      DO 40 I=1,5
      F(I)=ALOG((P(1)/P(I))*(R(I)/R(1))*G(I))
   40 CONTINUE
      TF=0
      DO 50 I=1,5
      TF=TF+F(I)
   50 CONTINUE
      Q=TF/TX
      DO 60 I=1,5
      POP(I)=D(I)/Q
   60 CONTINUE
   90 WRITE(6,300)
      DO 80 I=1,5
      WRITE(6,400)Y(I),C(I),E(I),D(I),G(I),SE(I),F(I),POP(I),P(I),R(I)
   80 CONTINUE
      WRITE(6,500)Q,TF,TX
  100 FORMAT(5F6.0)
  200 FORMAT(10F7.4)
  300 FORMAT(' ',T9,'YEAR',T21,'CATCH',T33,'EFFORT',T47,'C/E',T58,
     1'RATIO',T70,'SUM X',T82,'SUM F',T94,'POP',T106,'P(I)',T118,'R(I)')
```

```
400 FORMAT(' ',2X,F10.0,2X,F10.0,2X,F10.0,2X,F10.4,2X,F10.4,2X,F10.0,
   12X,F10.4,2X,F10.0,2X,F10.4,2X,F10.4)
500 FORMAT(' ',F12.6,6X,F12.4,6X,F12.0)

    GO TO 1000
    END
```

```
EXPECTED CATCH METHOD                                                      THPOP009
C                                                                          THPOP010
C      K.R.ALLEN,BIOLOGICAL STATION,NANAIMO,B.C.                           THPOP011
C      1130 FORTRAN, INCLUDES CEFF,RECCY,LSTSQ,AGPOP24/7/68                THPOP012
C      MODIFIED TO MINIMIZE SUM OF SQUARES FOR CATCHES WITH KNOWN EFFORT   THPOP013
C     123/7/68                                                             THPOP014
C
      DIMENSION NDATA(12),PTT(80,15),RGPP(80,84)
      DIMENSION POP  (2,40),KITL(80),XMORT(10),TOTCH(40),TOTRC(40,2)       THPOP016
      DIMENSION F(40),HEFF(40),CHKWN(40),CHOUT(40),PEW(15,40),RSEX(40)     THPOP017
      DIMENSION ADDF(40)                                                   THPOP018
      DIMENSION W(40),IZWW(80),KKK(80),UUU(40,2,84)
      COMMON POP,KITL,I1,IFIN,MM,III,IGG,IXR,TOTCH,TOTRC,HEFF,XMORT,F,     THPOP020
     1CHKWN,CHOUT,IFX,PEW,IG,RSEX,W                                        THPOP021
      COMMON IOUT1,IOUT2,ISX,IF1,IF2,MXT,MX1,MX2,IAGA                      THPOP022
      COMMON T,NDATA,MINA,MATF,ADDF,KKK,PTT,RGPP,UUU
      REAL KITL
      DATA BLANK/' '/
  200 READ(5,4)(KITL(K),K=1,80)                                            THPOP027
      DO 20 K=1,80
      IF(KITL(K).NE.BLANK) GO TO 8
   20 CONTINUE
      GO TO 300                                                            THPOP031
    1 FORMAT('1')
    8 WRITE(6,1)
      WRITE(6,7) (KITL(K),K=1,80)
      WRITE(6,2000)
      READ(5,31)IXR,(XMORT(I),I=1,10)
      READ(5,13)I1,IFIN,IOUT1,IOUT2
      WRITE(6,15)I1,IFIN                                                   THPOP052
      IF(IOUT1)21,21,22                                                    THPOP053
   21 IOUT1=I1                                                             THPOP054
   22 IF(I1-IOUT1)23,23,24                                                 THPOP055
   23 MX1=1
      WRITE(6,16)                                                          THPOP057
      GO TO 25                                                             THPOP058
   24 MX1=3
      WRITE(6,17)IOUT1                                                     THPOP060
   25 IF(IOUT2)26,26,27                                                    THPOP061
   26 IOUT2=IFIN                                                           THPOP062
   27 IF(IOUT2-IFIN)28,28,29                                               THPOP063
   28 MX2=1
      WRITE(6,18)                                                          THPOP065
      GO TO 30                                                             THPOP066
   29 MX2=3
      WRITE(6,19)IOUT2                                                     THPOP068
   30 MXT=(MX1+MX2)/2
      READ(  5,33)MINA,MATF
```

```
      WRITE(  6,32)MINA,MATF
      READ(5,2) (IZWW(I),I=1,80)
    2 FORMAT(80I1)
      DO 115 J=1,80
  115 KKK(J) = 2-IZWW(J)
      MINA=MINA+1                                                       THPOP071
      MATF=MATF+1                                                       THPOP072
      WRITE(6,2000)
      ISX=I1-IOUT1+1                                                    THPOP074
      IF1=IFIN-IOUT1+1                                                  THPOP075
      IF2=IOUT2-IOUT1+1                                                 THPOP076
      IFX=IFIN-I1+1                                                     THPOP077
      CALL  TCEFF                                                       THPOP078
      CALL  TECCY                                                       THPOP079
      III=1                                                             THPOP080
      IGG=1                                                             THPOP081
      CALL  TSTSQ
    4 FORMAT(80A1)                                                      THPOP083
    7 FORMAT(1H0,80A1)                                                  THPOP084
   13 FORMAT(17X,4I5)
   15 FORMAT(1H ,'STARTING YEAR FOR LEAST-SQUARE ESTIMATES=19',I2,', FINTHPOP086
     1ISHING YEAR=19',I2)                                               THPOP087
   16 FORMAT(1X,'NO BACKWARD EXTRAPOLATION')                            THPOP088
   17 FORMAT(1X,'STARTING YEAR FOR BACKWARD EXTRAPOLATION = 19',I2)     THPOP089
   18 FORMAT(1X,'NO FORWARD EXTRAPOLATION')                             THPOP090
   19 FORMAT(1X,'FINISHING FOR FORWARD EXTRAPOLATION = 19',I2)          THPOP091
   31 FORMAT(12X,I2,10F6.4)
 2000 FORMAT(1H0,'***** ***** ***** ***** ***** ***** ***** ***** ****',THPOP093
     C'* ***** ***** ***** ***** ***** ***** ***** ***** ***** *****'/) THPOP094
   32 FORMAT(1X,'MINIMUM AGE IN COMPLETE POPULATION ESTIMATES =',I3,/1X,THPOP095
     1'MINIMUM AGE OF MATURITY IN FEMALES =',I3)                        THPOP096
   33 FORMAT(12X,2I5)                                                   THPOP097
C                                                                       THPOP098
C                                                                       THPOP099
C                                                                       THPOP100
C      MAKE-UP  OF  DATA  DECKS                                         THPOP101
C                                                                       THPOP102
C    1  TITLE                                                           THPOP103
C     2 NO. OF NAT. MORT. RATES AND UP TO 10 VALUES                     THPOP104
C     3 FIRST AND LAST YEARS FOR POP. EST.                              THPOP105
C     4 MIN.AGE IN COMPLETE ESTIMATES MIN.AGE MATURITY IN FEMALES       THPOP106
C     5 CEFF DATA DECK (LAST CARD 9 IN COL.2)                           THPOP107
C     6 RECRUITMENT DATA DECK (LAST CARD 9 IN COL.2)                    THPOP108
C     7 AGE COMPOSITION DECK FROM YEARX(OPTIONAL)(LAST CARD 9 IN COL.2) THPOP109
C       ITEMS 1-7 CAN BE REPEATED INDEFINITELY                          THPOP110
C       BLANK CARD                                                      THPOP111
C                                                                       THPOP112
      GO TO 200
```

```
300 STOP
    END                                                               THPOP113

    SUBROUTINE TCEFF                                                  TCEFF006
    DIMENSION CPEM (40),CPET (40),CPEF (40),CHMT (40),CHFT (40)      TCEFF007
    DIMENSION CHMK (40),CHFK (40),EFT  (40),EMOD (40),CHMO (40)      TCEFF008
    DIMENSION PEW(15,40),TOEFF(40),CHFO(40),F(40),TOTCH(40),XMORT(10) TCEFF009
    DIMENSION HEFF (40),CHKWN(40),CHOUT(40),KITL (80),POP(2,40)      TCEFF010
    DIMENSION NDATA(12),PTT(80,15),RGPP(80,84),KKK(80)
    DIMENSION TOTRC(40,2),RSEX(40),W(40)                              TCEFF012
    DIMENSION ADDF(40),UUU(40,2,84)
    COMMON POP,KITL,I1,IFIN,MM,III,IGG,IXR,TOTCH,TOTRC,HEFF,XMORT,F, TCEFF014
   1CHKWN,CHOUT,IFX,PEW,IG,RSEX,W                                     TCEFF015
    COMMON IOUT1,IOUT2,ISX,IF1,IF2,MXT,MX1,MX2,IAGA                   TCEFF016
    COMMON T,NDATA,MINA,MATF,ADDF,KKK,PTT,RGPP,UUU
    DO 30 I=1,40                                                      TCEFF018
    EFT(I)=0.                                                         TCEFF019
    CHMK(I)=0.                                                        TCEFF020
    CHFK(I)=0.                                                        TCEFF021
    CHMT(I)=0.                                                        TCEFF022
    CHMO(I)=0.                                                        TCEFF023
    CHFO(I)=0.                                                        TCEFF024
    CHFT(I)=0.                                                        TCEFF025
    EMOD(I)=0.                                                        TCEFF026
    TOTCH(I)=0.0                                                      TCEFF027
 30 TOEFF(I)=0.0
 52 READ(5,40)IZZ,IYR,CHMTZ,CHFTZ,CHMKZ,CHFKZ,EFFZ,EMODZ,CHMOZ,CHFOZ
    IF(EMODZ) 1,2,1                                                   TCEFF030
  2 EMODZ = 1.                                                        TCEFF031
  1 IF(IZZ-9) 3,53,3
  3 IF(IYR-IOUT1)52,13,13
 13 IF(IYR-IOUT2)14,14,52
 14 I=IYR-IOUT1+1
    CHMT(I)=CHMTZ                                                     TCEFF036
    CHFT(I)=CHFTZ                                                     TCEFF037
    CHMK(I)=CHMKZ                                                     TCEFF038
    CHFK(I)=CHFKZ                                                     TCEFF039
    CHMO(I)=CHMOZ                                                     TCEFF040
    CHFO(I)=CHFOZ                                                     TCEFF041
    EFT(I)=EFFZ                                                       TCEFF042
    EMOD(I)=EMODZ                                                     TCEFF043
    GO TO 52                                                          TCEFF044
 53 DO 55 I=1,40                                                      TCEFF045
    TOTCH(I)=CHMT(I)+CHFT(I)                                          TCEFF046
    CHKWN(I)=CHMK(I)+CHFK(I)                                          TCEFF047
    CHOUT(I)=CHMO(I)+CHFO(I)                                          TCEFF048
    IF(TOTCH(I))100,101,100                                           TCEFF049
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```
 101 RSEX(I)=0.5
     GO TO 102                                                        TCEFF051
 100 RSEX(I)=CHMT(I)/TOTCH(I)
 102 IF(EFT(I)*EMOD(I)) 4,60,4
  60 CPEM(I)=0.                                                       TCEFF054
     CPEF(I)=0.                                                       TCEFF055
     TOEFF(I)=0.                                                      TCEFF056
     GO TO 56                                                         TCEFF057
   4 CPEM(I)=CHMK(I)/(EFT(I)*EMOD(I))                                 TCEFF058
     CPEF(I)=CHFK(I)/(EFT(I)*EMOD(I))                                 TCEFF059
     IF(CHMK(I)+CHFK(I)) 5,61,5                                       TCEFF060
  61 TOEFF(I)= EFT(I) *EMOD(I)                                        TCEFF061
     GO TO 56                                                         TCEFF062
   5 TOEFF(I)=EFT(I)*(CHMT(I)+CHFT(I))/(CHMK(I)+CHFK(I))*EMOD(I)      TCEFF063
  56 CPET(I)=CPEM(I)+CPEF(I)                                          TCEFF064
     HEFF(I)=EFT(I)*EMOD(I)                                           TCEFF065
  55 CONTINUE
     WRITE(6,2000)
     WRITE(6,1000) (KITL(K),K=1,80)
     WRITE(6,71)
     WRITE(6,2000)
     DO 50 I=1,40                                                     TCEFF071
     IF(TOTCH(I)+CHMO(I)+CHFO(I))7,6,7                                TCEFF072
   6 IF(TOEFF(I)) 7,50,7                                              TCEFF073
   7 IDATE=I+IOUT1+1899
     WRITE(6,72)IDATE,CHMK(I),CHFK(I),CHMT(I),CHFT(I),CHMO(I),CHFO(I), TCEFF075
    1EFT(I),EMOD(I),CPEM(I),CPEF(I),CPET(I),TOEFF(I),HEFF(I)          TCEFF076
  50 CONTINUE                                                         TCEFF077
     WRITE(6,2000)
     RETURN                                                           TCEFF079
  40 FORMAT  (1X,I1,3X,I2,5X,5F10.1,F6.4,2F6.0)
  71 FORMAT(1H ,21X,5HCATCH/11X,12HKNOWN EFFORT,9X,5HTOTAL,6X,14HOUTSIDTCEFF081
    1E SEASON,4X,5HKNOWN,12X,16HCATCH PER EFFORT,4X,'POT.MOD.',8HKWN.MOTCEFF082
    2D.,/1X,4HYEAR,5X,4HMALE,3X,6HFEMALE,5X,4HMALE,3X,6HFEMALE,4X,4HMALTCEFF083
    3E,2X,6HFEMALE,2X,6HEFFORT,1X,8HMODIFIER,3X,4HMALE,2X,6HFEMALE,3X,5TCEFF084
    4HTOTAL,2X,6HEFFORT,2X,6HEFFORT)                                  TCEFF085
  72 FORMAT(1X,I4,4F9.0,2F8.0,F9.1,4F8.4,2F8.1)                       TCEFF086
1000 FORMAT(1X,80A1)                                                  TCEFF087
2000 FORMAT(1H0,'***** ***** ***** ***** ***** ***** ***** ***** ****',TCEFF088
    C'* ***** ***** ***** ***** ***** ***** ***** ***** ***** *****'/) TCEFF089
     END                                                              TCEFF090

     SUBROUTINE TECCY                                                 TECCY006
     DIMENSION PTT(80,15),RGPP(80,84),KKK(80)
     DIMENSION RGTMP(84),NDATA(12),IDATA(12)                          TECCY007
     DIMENSION MNO(15) ,RSEX(40),W(40)                                TECCY008
     DIMENSION POP(2,40),KITL(80),XMORT(10),TOTCH(40),TOTRC(40,2),F(40)TECCY009
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```
      DIMENSION HEFF(40),CHKWN(40),CHOUT(40),PEW(15,40),PT(15),IRDAT(10)TECCY010
      DIMENSION ADDF(40),UUU(40,2,84)                                   TECCY012
      COMMON POP,KITL,I1,IFIN,MM,III,IGG,IXR,TOTCH,TOTRC,HEFF,XMORT,F,  TECCY013
     1CHKWN,CHOUT,IFX,PEW,IG,RSEX,W                                     TECCY014
      COMMON IOUT1,IOUT2,ISX,IF1,IF2,MXT,MX1,MX2,IAGA
      COMMON T,NDATA,MINA,MATF,ADDF,KKK,PTT,RGPP,UUU                    TECCY016
      DO 1 K=1,2                                                        TECCY017
      DO 1  J=1,40
    1 TOTRC(J,K) =0.0                                                   TECCY019
      DO 20 J=1,15                                                      TECCY020
      DO 20 K=1,40                                                      TECCY021
   20 PEW(J,K)=0.0                                                      TECCY022
      READ(5,55)(IRDAT(M),M=1,5),IYR,(IRDAT(M),M=6,10),WK,IG,IAGA,(PT(I)TECCY023
     1,I=1,7),T,(PT(I),I=8,15),I79
      IZZ=IRDAT(2)
   55 FORMAT(5I1,I2,5I1,F7.4,2I3,4X,7F7.4,2X,/,15X,9F7.4,1A1)           TECCY026
      GO TO 8
    6 READ(5,50) IZZ,IYR,WK,IG,(PT(I),I=1,15)
    8 IF(IZZ-9)2,33,2
    2 IF(IYR-IOUT1)6,13,13
   13 IF(IYR-IOUT2)14,14,6
   14 IYY=IYR-IOUT1+1
      ISEX = IZZ                                                        TECCY033
      TOTRC(IYY,ISEX)=WK                                                TECCY034
      IDX=2*IYY-2+ISEX
      DO 300 I=1,15
  300 PTT(IDX,I)=PT(I)                                                  TECCY036
      DO 21 JJ=1,15                                                     TECCY037
      GO TO (121,122),ISEX
  121 PEW(JJ,IYY)=PEW(JJ,IYY)+RSEX(IYY)*PT(JJ)                          TECCY039
      GO TO 21
  122 PEW(JJ,IYY)=PEW(JJ,IYY)+(1.0-RSEX(IYY))*PT(JJ)
   21 CONTINUE                                                          TECCY042
      DO 125 J=1,IF2
  125 W(J)=TOTRC(J,1)*RSEX(J)+TOTRC(J,2)*(1.0-RSEX(J))                  TECCY044
      GO TO 6
   33 WRITE(6,54)
      WRITE(6,2000)
      WRITE(6,52) KITL,IRDAT,I79
      WRITE(  6,57)IG,IAGA,T
   57 FORMAT(1H0,'AGE AT FIRST RECRUITMENT',I5,' AGE AT FULL RECRUITMENTTECCY051
     1',I5,/1X,'T',F8.4)                                                TECCY052
      IAGA=IAGA+1                                                       TECCY053
      DO 22 MM=1,15                                                     TECCY054
      MZ=MM+IG-1                                                        TECCY055
   22 MNO(MM)=MZ                                                        TECCY056
      WRITE(6,56)MNO
      WRITE(6,2000)
```

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                                                                        TECCY059
      DO 4 K=1,IF2                                                      TECCY060
      KY=K+IOUT1-1
      WRITE(6,53)KY,W(K),       (PEW(JJ,K),JJ=1,15)                     TECCY062
    4 CONTINUE
      WRITE(6,2000)                                                     TECCY066
   25 CONTINUE
   18 READ(5,102) IDATA(1),IZZ,(IDATA(I),I=3,5),IYR,(IDATA(I),I=8,12),  TECCY068
     1(RGTMP(I),I=1,11)
      IF(IZZ-9) 11,23,11
      ISEX = IZ
   11 IF(IYR-IOUT1)18,32,32
   32 IF(IYR-IOUT2)31,31,18
   31 IYR=IYR-IOUT1 + 1
      READ(5,110)(RGTMP(I),I=12,84)                                     TECCY075
      DO 1111 I=1,12
 1111 NDATA(I)=IDATA(I)                                                 TECCY077
      JYR=IYR*2-2+ISEX
      DO 301 I=1,84
  301 RGPP(JYR,I) = RGTMP(I)                                            TECCY079
      GO TO 18                                                          TECCY080
   23 CONTINUE
   26 RETURN                                                            TECCY082
   50 FORMAT(1X,I1,3X,I2,5X,F7.4,I3,7X,7F7.4,2X,/,22X,8F7.4)            TECCY083
   52 FORMAT(1H ,80A1,/,2X,'DATA ON RECRUITMENT CARDS',2X,5A1,2X,6A1)
   53 FORMAT(1HN,I3,1X,16F7.4)
   54 FORMAT(1H1,' ')                                                   TECCY086
   56 FORMAT(1H0,'YEAR',30X,'RECRUITMENT AT AGE',/,7X,'TOTAL',15I7)
  102 FORMAT(5I1,I2,5I1,11F6.4)
  110 FORMAT(12X,11F6.4,2X)  ***** ***** ***** ***** ***** ***** ****',TECCY089
 2000 FORMAT(1H0,'***** ***** ***** ***** ***** ***** ***** ***** *****'/) TECCY090
     C'* ***** ***** ***** ***** ***** ***** ***** ***** *****          TECCY091
      END


      SUBROUTINE TSTSQ                                                  TSTSQ010
      DIMENSION W(40),AT(40),FC(40),IYR(40),EXC(40),DIFF(40),DSQ(40)    TSTSQ011
      DIMENSION POP(2,40),KITL(80),XMORT(10),TOTCH(40),TOTRC(40,2),F(40)TSTSQ012
      DIMENSION HEFF(40),CHKWN(40),CHOUT(40),PROP(40),PEW(15,40)
      DIMENSION NDATA(12),PTT(80,15),RGPP(80,84),KKK(80),ADDF(40)
      DIMENSION RSEX(40),UUU(40,2,84)                                   TSTSQ016
      COMMON POP,KITL,I1,IFIN,MM,III,IGG,IXR,TOTCH,TOTRC,HEFF,XMORT,F,  TSTSQ017
     1CHKWN,CHOUT,IFX,PEW,IG,RSEX,W                                     TSTSQ018
      COMMON IOUT1,IOUT2,ISX,IF1,IF2,MXT,MX1,MX2,IAGA
      COMMON T,NDATA,MINA,MATF,ADDF,KKK,PTT,RGPP,UUU                    TSTSQ022
      IF(III-1)200,200,202                                              TSTSQ023
  200 MM=1
  202 IF(III-IXR)201,201,204
  201 EXM=EXP(-XMORT(III))
```

```
      KZ=2                                                              TSTSQ026
      DO 10 I=1,40                                                      TSTSQ027
      AT(I)=0.0                                                         TSTSQ028
   10 FC(I)=0.0
      W(1)=0.0                                                          TSTSQ030
      AT(ISX)=1.0                                                       TSTSQ031
      FC(ISX)=TOTCH(ISX)+CHOUT(ISX)                                     TSTSQ032
      IS2=ISX+1                                                         TSTSQ033
      DO 11 I=IS2,IF1                                                   TSTSQ034
      AT(I)=AT(I-1)*EXM/(1.-W(I))                                       TSTSQ035
   11 FC(I)=FC(I-1)+TOTCH(I)/AT(I)+CHOUT(I)/AT(I)                       TSTSQ036
      SUML=TOTCH(ISX)*CHKWN(ISX)*HEFF(ISX)                              TSTSQ037
      SUMU=(TOTCH(ISX)*HEFF(ISX))**2/4.0                                TSTSQ038
      SUMR=-TOTCH(ISX)*HEFF(ISX)**2*AT(ISX)                             TSTSQ039
      SUMG = 0.0                                                        TSTSQ040
      SUMK=0.0                                                          TSTSQ041
      SUMP=0.0                                                          TSTSQ042
      SUMS=0.0                                                          TSTSQ043
      SUMF = 0.0                                                        TSTSQ044
      SUMH = 0.0                                                        TSTSQ045
      SUMZ = 0.0                                                        TSTSQ046
      DO 122 I=1,IF2                                                    TSTSQ047
  122 IYR(I)=I+IOUT1+1899
      KYK = KKK(13)
      GO TO (313,314),KYK
  313 WRITE(6,101)
  314 DO 12 I=ISX,IF1
      SUMK = SUMK + CHKWN(I)*CHKWN(I)                                   TSTSQ053
      SUMP= SUMP-2.0*CHKWN(I)*HEFF(I)*AT(I)                             TSTSQ054
      SUMS= SUMS+(HEFF(I)*AT(I))**2                                     TSTSQ055
      SUMF = SUMF+AT(I)*HEFF(I)                                         TSTSQ056
      SUMH = SUMH+TOTCH(I)*HEFF(I)                                      TSTSQ057
      SUMZ = SUMZ+CHKWN(I)                                              TSTSQ058
      KYK = KKK(13)
      GO TO (112,12),KYK
  112 WRITE(6,100) I,SUMK,SUMP,SUMS,SUMF,SUMH,SUMZ
   12  CONTINUE
      KYK = KKK(13)
      GO TO (315,316),KYK
  315 WRITE(6,102)
      WRITE(6,103) SUML,SUMU,SUMR,SUMG
  316 DO 312 I=IS2,IF1
      SUML= SUML+TOTCH(I)*CHKWN(I)*HEFF(I)+2.0*CHKWN(I)*HEFF(I)*AT(I)*  TSTSQ066
     1FC(I-1)                                                           TSTSQ067
      SUMU= SUMU+(TOTCH(I)*HEFF(I))**2/4.0+TOTCH(I)*HEFF(I)**2*AT(I)*   TSTSQ068
     1FC(I-1)+ (HEFF(I)*AT(I)*FC(I-1))**2                               TSTSQ069
      SUMR= SUMR-TOTCH(I)*HEFF(I)**2*AT(I)-2.*(HEFF(I)*AT(I))**2*FC(I-1)TSTSQ070
      SUMG = SUMG+AT(I)*HEFF(I)*FC(I-1)                                 TSTSQ071
```

```
      KYK = KKK(13)
      GO TO (3112,312),KYK
 3112 WRITE(6,103) SUML,SUMU,SUMR,SUMG
  312 CONTINUE                                                           TSTSQ074
      POP(2,ISX)=(SUML*SUMR-2.0*SUMU*SUMP)/(SUMR*SUMP-2.0*SUMS*SUML)     TSTSQ075
      Q=(SUMR*SUMP-2.0*SUMS*SUML)/(4.0*SUMS*SUMU-SUMR*SUMR)              TSTSQ076
      DO 400 K=IS2,IF1                                                   TSTSQ077
      J=IF1+IS2-K                                                        TSTSQ078
  400 FC(J)=FC(J-1)                                                      TSTSQ079
      FC(ISX)=0.0                                                        TSTSQ080
   30 DO 15 I=ISX,IF1
   15 F(I)=Q*HEFF(I)                                                     TSTSQ082
      DO 13 I=IS2,IF1                                                    TSTSQ083
   13 POP(KZ,I)=AT(I)*(POP(KZ,ISX)-FC(I))
      SSQ=0.                                                             TSTSQ085
      DO 14 I=ISX,IF1                                                    TSTSQ086
      EXC(I)=Q*HEFF(I)*(POP(KZ,I)-TOTCH(I)/2.)                           TSTSQ087
      DIFF(I)=CHKWN(I)-EXC(I)                                            TSTSQ088
      PROP(I)=1.0-EXC(I)/CHKWN(I)                                        TSTSQ089
      DSQ(I)=DIFF(I)*DIFF(I)                                             TSTSQ090
   14 SSQ=SSQ+DSQ(I)                                                     TSTSQ091
      SSQ2=SUMK+SUML*Q+SUMU*Q*Q+SUMP*POP(KZ,ISX)*Q+SUMR*POP(KZ,ISX)*Q*Q TSTSQ092
     1+SUMS*(POP(KZ,ISX)*Q)**2                                           TSTSQ093
      WRITE(6,21)(KITL(I),I=1,80)
      WRITE(6,22)
      WRITE(6,23)XMORT(III)
      WRITE(6,2000)
      WRITE(6,24)
      WRITE(6,2000)
      WRITE(6,26)(IYR(I),AT(I),FC(I),POP(KZ,I),CHKWN(I),EXC(I),DIFF(I),
     CPROP(I),DSQ(I),I=ISX,IF1)                                          TSTSQ101
      SEXC = 0.                                                          TSTSQ102
      DO 16 I=ISX,IF1                                                    TSTSQ103
   16 SEXC = SEXC+EXC(I)                                                 TSTSQ104
      WRITE(6,104)SUMZ,SEXC
      WRITE(6,27)Q,SSQ
      WRITE(6,28)SSQ2
      WRITE(6,2000)
   32 JK=0
      III=III+1                                                          TSTSQ121
   35 GO TO (50,51,51),MXT
   51 CALL TXTRP(EXM,IYR)                                                TSTSQ138
   50 CONTINUE                                                           TSTSQ139
      KYK = KKK(8)
      GO TO (52,53),KYK
   52 CALL TRPOP(IYR,EXM)                                                TSTSQ142
   53 KYK = KKK(11)
      GO TO (40,41),KYK
```

```
   40 CALL TGPOP
   41 GO TO 202
  204 CALL THEND
   34 JK=1
      READ (5,108) QUIT
   21 FORMAT(1H1,80A1)                                                  TSTSQ151
   22 FORMAT (1H0,43HPOPULATION ESTIMATE BY LEAST SQUARES METHOD)      TSTSQ152
   23 FORMAT (1H0,38HINSTANTANEOUS NATURAL MORTALITY RATE =,F7.4)       TSTSQ153
   24 FORMAT(1H ,4HYEAR,10X,5HAT(I),8X,7HFC(I-1),6X,9HEST. POP.,5X,10HAC
     1T. CATCH,5X,10HEXP. CATCH,5X,10HDIFFERENCE,1X,9HPROP.DIFF,7X,8HDIFTSTSQ155
     2F(SQ))                                                            TSTSQ156
   26 FORMAT (1HN,I4,8X,F7.4,5X,F10.0,5X,F10.0,5X,F10.1,5X,F10.1,5X,F10.TSTSQ157
     11,3X,F7.4,1X,F14.2)                                               TSTSQ158
   27 FORMAT(/18X,15HESTIMATE OF Q= ,E12.5,40X,17HSUM OF SQUARES = ,F18.TSTSQ159
     12)                                                                TSTSQ160
   28 FORMAT(75X,27HESTIMATED SUM OF SQUARES = ,F18.2)                  TSTSQ161
  100 FORMAT(1X,I2,6E15.8)                                              TSTSQ162
  101 FORMAT(2H1I,11X,4HSUMK,11X,4HSUMP,11X,4HSUMS,11X,4HSUMF,11X,4HSUMHTSTSQ163
     1,11X,4HSUMZ)                                                      TSTSQ164
  102 FORMAT(13X,4HSUML,11X,4HSUMU,11X,4HSUMR,11X,4HSUMG)               TSTSQ165
  103 FORMAT(3X,4E15.8)                                                 TSTSQ166
  104 FORMAT(/44X,11HTOTAL CATCH,F10.1,5X,F10.1)                        TSTSQ167
  105 FORMAT (1H1,25X,1HQ, 9X,6HPOP(1), 1X,'SUM OF SQUARES')
  106 FORMAT (10X,3E15.6)
  107 FORMAT('SWITCH   9 OFF TO CONTINUE - ON TO ALTER Q BY CONSOL'/'FOR
     1MAT IS 9.7')                                                      TSTSQ171
  108 FORMAT (F9.7)
 2000 FORMAT(1H0,'***** ***** ***** ***** ***** ***** ***** ***** ****',
     C'* ***** ***** ***** ***** ***** ***** ***** ***** ***** *****'/) TSTSQ174
      RETURN
      END                                                               TSTSQ175


      SUBROUTINE TXTRP(EXM,IYR)                                         TXTRP006
      DIMENSION POP(2,40),KITL(80),XMORT(10),TOTCH(40),TOTRC(40,2),F(40)TXTRP007
      DIMENSION HEFF(40),CHKWN(40),CHOUT(40),PEW(15,40)                 TXTRP008
      DIMENSION IYR(40),W(40),RSEX(40)                                  TXTRP009
      DIMENSION NDATA(12),PTT(80,15),RGPP(80,84),KKK(80)
      DIMENSION PGG(2,84),PWG(2,15),UU(2,84),R2(2,84),RR(2,84),ADDU(40) TXTRP011
      DIMENSION ADDF(40),ADPOP(40)                                      TXTRP012
      DIMENSION ETOF(40),UUU(40,2,84)
      COMMON POP,KITL,I1,IFIN,MM,III,IGG,IXR,TOTCH,TOTRC,HEFF,XMORT,F,  TXTRP014
     1CHKWN,CHOUT,IFX,PEW,IG,RSEX,W                                     TXTRP015
      COMMON IOUT1,IOUT2,ISX,IF1,IF2,MXT,MX1,MX2,IAGA                   TXTRP016
      COMMON T,NDATA,MINA,MATF,ADDF,KKK,PTT,RGPP,UUU
      DO 32 J=1,40
      DO 32 K=1,2
      DO 41 L=1,IAGA
```

```
   41 UUU(J,K,L) = 0.0
      MM = IAGA + 1
      DO 33 L=MM,84
   33 UUU(J,K,L) = 1.0
   32 CONTINUE
      KZ = KKK(10)
      IF(MX1-1)12,12,11                                                 TXTRP019
   11 JSX=ISX-1
      DO 12 J=1,JSX                                                     TXTRP021
      JTX=ISX-J                                                         TXTRP022
      POP(KZ,JTX)=POP(KZ,JTX+1)*(1.0-W(JTX+1))/EXM+TOTCH(JTX)+CHOUT(JTX)TXTRP023
   12 CONTINUE                                                          TXTRP024
      JF1=IF1+1                                                         TXTRP025
      IF(MX2-1)13,13,14                                                 TXTRP026
   14 DO 13 J=JF1,IF2                                                   TXTRP027
      POP(KZ,J)=(POP(KZ,J-1)-TOTCH(J-1)-CHOUT(J-1))*EXM/(1-W(J))        TXTRP028
   13 CONTINUE                                                          TXTRP029
      DO 31 I=1,IF2                                                     TXTRP030
   31 ETOF(I)=POP(KZ,I)/(POP(KZ,I)-TOTCH(I)-CHOUT(I))                   TXTRP031
      DO 20 J=1,IF2                                                     TXTRP032
      JJ=IF2-J+1                                                        TXTRP033
      JJF=JJ*2                                                          TXTRP034
      JJM=JJF-1                                                         TXTRP035
      DO 200 I=1,84
      PGG(2,I) = RGPP(JJF,I)
  200 PGG(1,I) = RGPP(JJM,I)
      DO 201 I=1,15
      PWG(2,I) = PTT(JJF,I)
  201 PWG(1,I) = PTT(JJM,I)
      DO 22 ISEX=1,2                                                    TXTRP040
      R2(ISEX,IAGA+1)=0.0                                               TXTRP041
      UU(ISEX,IAGA+1)=1.0                                               TXTRP042
      DO 21 K=IG,IAGA
      KKKKK=K-IG+1                                                      TXTRP044
      RR(ISEX,K)=PWG(ISEX,KKKKK )/( PGG(ISEX,K))                        TXTRP045
      IF(J-1)23,23,21                                                   TXTRP046
   23 R2(ISEX,K)=RR(ISEX,K)                                             TXTRP047
      R2(ISEX,IAGA+1)=R2(ISEX,IAGA)                                     TXTRP048
   21 CONTINUE                                                          TXTRP049
      DO 24 K=IG,IAGA
      KK=IAGA-K+MINA                                                    TXTRP051
      UU(ISEX,KK)=(UU(ISEX,KK+1)*ETOF(JJ))/(UU(ISEX,KK+1)*(ETOF(JJ)-1.0)TXTRP052
     1+(1.0/(1.0-R2(ISEX,KK+1))))                                       TXTRP053
      UUU(JJ,ISEX,KK) = UU(ISEX,KK)
   24 CONTINUE
      DO 27 K=MINA,IAGA                                                 TXTRP059
   27 R2(ISEX,K)=RR(ISEX,K)                                             TXTRP060
      R2(ISEX,IAGA+1)=R2(ISEX,IAGA)                                     TXTRP061
```

```
   22 CONTINUE                                                        TXTRP062
      ADDU(JJ)=0.0                                                    TXTRP063
      DO 25 K=MINA,IAGA                                               TXTRP064
      ADDU(JJ)=ADDU(JJ)+RSEX(JJ)*PGG(1,K)*(1.0/UU(1,K)-1.0)+(1.0-RSEX(JJTXTRP065
     1))*PGG(2,K)*(1.0/UU(2,K)-1.0)                                   TXTRP066
   25 CONTINUE                                                        TXTRP072
      MIN2=MINA-1                                                     TXTRP073
      DO 26 K=1,MIN2                                                  TXTRP074
      ADDU(JJ)=ADDU(JJ)-RSEX(JJ)*PGG(1,K)-(1.0-RSEX(JJ))*PGG(2,K)     TXTRP075
   26 CONTINUE                                                        TXTRP076
      ADDF(JJ)=1.0                                                    TXTRP077
      DO 28 K=1,IAGA                                                  TXTRP078
      IF(K-MATF)29,30,30                                              TXTRP079
   29 ADDF(JJ)=ADDF(JJ)-PGG(2,K)                                      TXTRP080
      GO TO 28                                                        TXTRP081
   30 ADDF(JJ)=ADDF(JJ)+PGG(2,K)*(1.0/UU(2,K)-1.0)                    TXTRP082
   28 CONTINUE                                                        TXTRP083
      ADDF(JJ)=ADDF(JJ)*(1.0-RSEX(JJ))                                TXTRP084
   20 CONTINUE                                                        TXTRP089
      MINO = MINA - 1
      WRITE(6,101) MINO
      DO 15 J=1,IF2                                                   TXTRP091
      IF(J-ISX)17,16,17                                               TXTRP092
   17 IF(J-IF1-1)19,16,19                                             TXTRP093
   16 WRITE(6,102)
   19 RXX=POP(KZ,J)*W(J)                                              TXTRP095
      ADPOP(J)=POP(KZ,J)*(1.0 +ADDU(J))                               TXTRP096
      WRITE(  6,103)IYR(J),POP(KZ,J),ADPOP(J),RXX
   15 CONTINUE
      RETURN                                                          TXTRP099
  101 FORMAT(1H1,'ESTIMATED POPULATION AND NO. OF NEW RECRUITS IN EACH YTXTRP100
     1EAR, INCLUDING EXTRAPOLATIONS'/16X,'EXPLOITED',10X,'POPULATION',/ TXTRP101
     21X,'YEAR',10X,'POPULATION',7X,'AGE',I3,1X,'AND OVER',10X,'RECRUITSTXTRP102
     3')                                                              TXTRP103
  102 FORMAT(1X,22(2H- ))                                             TXTRP104
  103 FORMAT(1X,I4,10X,F10.0,10X,F10.0,10X,F10.0)                     TXTRP105
      END                                                             TXTRP106


      SUBROUTINE TRPOP(IYR,EXM)                                       TRPOP006
      DIMENSION ADDF(40)
      DIMENSION EMM(2),IYR(40),TRG(55),RGG(40),MARK(2)                TRPOP008
      DIMENSION POP(2,40),KITL(80),XMORT(10),TOTCH(40),TOTRC(40,2),F(40)TRPOP009
      DIMENSION HEFF(40),CHKWN(40),CHOUT(40),PEW(15,40)               TRPOP010
      DIMENSION NDATA(12),PTT(80,15),RGPP(80,84),KKK(80)
      DIMENSION RAGE(15),UUU(40,2,84),URGM(40),URGF(40),URGG(40)
      DIMENSION RSEX(40),W(40),PEWM(15),PEWF(15),RGM(40),RGF(40),TRM(55)TRPOP013
     1,TRF(55)                                                        TRPOP014
```

```
      COMMON POP,KITL,I1,IFIN,MM,III,IGG,IXR,TOTCH,TOTRC,HEFF,XMORT,F,  TRPOP015
     1CHKWN,CHOUT,IFX,PEW,IG,RSEX,W                                     TRPOP016
      COMMON IOUT1,IOUT2,ISX,IF1,IF2,MXT,MX1,MX2,IAGA                   TRPOP017
      COMMON T,NDATA,MINA,MATF,ADDF,KKK,PTT,RGPP,UUU
      DATA MARK(1),MARK(2)/' ','*'/
      KZ = KKK(10)
      WRITE(6,101)KITL
      WRITE(6,109)
      IAA=IAGA-1                                                        TRPOP022
      EMM(1)=1.0                                                        TRPOP023
      EMM(2)=EXM*T                                                      TRPOP024
      EAM=-ALOG(EXM)                                                    TRPOP025
      DO 22 MEM=1,2                                                     TRPOP026
      SUM=0.0                                                           TRPOP027
      JAG=IAGA-IG+1                                                     TRPOP028
      DO 30 J=1,15                                                      TRPOP029
   30 RAGE(J)=0.0                                                       TRPOP030
      WRITE(6,102)
      WRITE(6,104)
      WRITE(6,103)(IYR(J),J=1,IF2)
      JGG=IF2+IAGA-IG-1                                                 TRPOP034
      LGG=IAGA                                                          TRPOP035
      DO 10 J=1,JGG                                                     TRPOP036
      IRX=IOUT1-IAGA+J+1900                                             TRPOP037
      TRG(J)=0.0                                                        TRPOP038
      TRM(J)=0.0                                                        TRPOP039
      TRF(J)=0.0                                                        TRPOP040
      DO 11 K=1,IF2                                                     TRPOP041
      L=2*K-1                                                           TRPOP042
      KK=2*K                                                            TRPOP044
      DO 200 I=1,15
      PEWM(I) = PTT(L,I)
  200 PEWF(I) = PTT(KK,I)
      KGG=K-J-IG+IAGA                                                   TRPOP046
      IF(KGG-IAGA)12,12,13                                              TRPOP047
   12 IF(KGG)13,13,14                                                   TRPOP048
   13 RGG(K)=0.0                                                        TRPOP049
      GO TO 11                                                          TRPOP050
   14 RGM(K)=POP(KZ,K)*PEWM(KGG)*RSEX(K)*EMM(MEM)**(J-K)                TRPOP051
      RGF(K)=POP(KZ,K)*PEWF(KGG)*(1.0-RSEX(K))*EMM(MEM)**(J-K)          TRPOP052
      RGG(K)=RGM(K)+RGF(K)                                              TRPOP053
      KTA = KGG + IG - 1
      IF(UUU(K,1,KTA)) 60,60,61
   61 URGM(K) = RGM(K)/UUU(K,1,KTA)
      URGF(K) = RGF(K)/UUU(K,2,KTA)
      URGG(K) = URGM(K)+URGF(K)
      GO TO 62
   60 URGM(K) = 0.0
```

```
      URGF(K) = 0.0
      URGG(K) = 0.0
   62 TRM(J) = TRM(J)+RGM(K)
      TRF(J)=TRF(J)+RGF(K)                                        TRPOP055
      RAGE(KGG)=RAGE(KGG)+RGG(K)                                  TRPOP056
   11 CONTINUE                                                    TRPOP057
      TRG(J)=TRM(J)+TRF(J)                                        TRPOP058
      SUM=SUM+TRG(J)                                              TRPOP059
      WRITE(6,111)IRX,TRG(J)
      WRITE(6,105)     (RGG(K),K=1,IF2)
      WRITE(6,105) (URGG(K),K=1,IF2)
      WRITE(6,112)
   10 CONTINUE                                                    TRPOP063
      SUB=0.0                                                     TRPOP066
      LIST=1                                                      TRPOP067
      LAST=JAG-1                                                  TRPOP068
   38 IF(RAGE(LIST)-RAGE(LAST))35,35,36                           TRPOP069
   35 SUB=SUB+RAGE(LIST)                                          TRPOP070
      IF(SUB-SUM*0.05)40,40,39                                    TRPOP071
   40 LIST=LIST+1                                                 TRPOP072
      GO TO 38                                                    TRPOP073
   36 SUB=SUB+RAGE(LAST)                                          TRPOP074
      IF(SUB-SUM*0.05)37,37,39                                    TRPOP075
   37 LAST=LAST-1                                                 TRPOP076
      GO TO 38                                                    TRPOP077
   39 CONTINUE                                                    TRPOP078
      LAST=LAST + 1                                               TRPOP079
      WRITE(6,113)
      JJG=JAG-1                                                   TRPOP081
      DO 41 J=1,JJG                                               TRPOP082
      MAGE=J+IG-1                                                 TRPOP083
      IF(J-LIST)42,43,43                                          TRPOP084
   42 JMK=2                                                       TRPOP085
      GO TO 45                                                    TRPOP086
   43 IF(J-LAST)44,42,42                                          TRPOP087
   44 JMK=1                                                       TRPOP088
   45 POOP=RAGE(J)/SUM                                            TRPOP089
   41 WRITE(6,114)MAGE,RAGE(J),POOP,MARK(JMK)
      WRITE(6,115)
      WRITE(6,107)
      DO 16 J=LGG,JGG                                             TRPOP093
      IF(JGG-J-LAST)50,52,52                                      TRPOP094
   50 JMK=2                                                       TRPOP095
      GO TO 53                                                    TRPOP096
   52 JMK=1                                                       TRPOP097
   53 IF(J-IAGA+IG)17,18,18                                       TRPOP098
   17 PPP=0.0                                                     TRPOP099
      PERK=0.0                                                    TRPOP100
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      GO TO 21                                                          TRPOP101
   18 JJJJJ=J-IAGA+1                                                    TRPOP102
      PPP=POP(KZ,JJJJJ)                                                 TRPOP103
      PERK=TRG(J)/PPP                                                   TRPOP104
      PFF=PPP * ADDF(JJJJJ)                                             TRPOP105
      PERM=TRM(J)/PPP                                                   TRPOP106
      PERF=TRF(J)/PPP                                                   TRPOP107
      PEFM=TRM(J)/PFF                                                   TRPOP108
      PEFF=TRF(J)/PFF                                                   TRPOP109
      PEFK=TRG(J)/PFF                                                   TRPOP110
   21 IRX=IOUT1-IAGA+J+1900                                             TRPOP111
      WRITE(6,108)IRX,PPP,PFF,TRM(J),TRF(J),TRG(J),PERM,PERF,PERK,PEFM,
     1PEFF,PEFK,MARK(JMK)                                               TRPOP113
   16 CONTINUE                                                          TRPOP114
      WRITE(6,116)
      GO TO (23,22),MEM                                                 TRPOP116
   23 WRITE(6,110)EAM,T,IAA
   22 CONTINUE                                                          TRPOP118
      RETURN                                                            TRPOP119
  101 FORMAT(1H1,80A1)                                                  TRPOP120
  102 FORMAT(1H0 'DISTRIBUTION OF RECRUITMENT FROM EACH YEAR-CLASS'//1X,TRPOP121
     C'YEAR' 46X,'Y  E  A  R    O  F'/1X,'CLASS',38X,'R  E  C  R  U  I  TRPOP122
     CT  M  E  N  T')                                                   TRPOP123
  103 FORMAT(11X,10I10,10X)                                             TRPOP124
  104 FORMAT(1H+,112X,'TOTAL')                                          TRPOP125
  105 FORMAT(11X,10F10.0/)
  107 FORMAT(1H1,'RECRUITMENT SUMMARY'//1X,'YEAR',5X,'POPULATION',16X,  TRPOP127
     1'RECRUITS',29X,'PROPORTION OF RECRUITS',/19X,'MATURE',41X,'PER ADUTRPOP128
     2LT',17X,'PER MATURE FEMALE'/10X,'TOTAL',4X,'FEMALE',3(6X,'MALE',4 TRPOP129
     3X,'FEMALE',5X,'TOTAL'))                                           TRPOP130
  108 FORMAT(1X,I4,5F10.0,6F10.4,1A1)                                   TRPOP131
  109 FORMAT(1H0,'A.  RECRUITMENT NOT ADJUSTED FOR NATURAL MORTALITY')  TRPOP132
  110 FORMAT(1H1,'B.  RECRUITMENT ADJUSTED BY NATURAL MORTALITY AT STANDTRPOP133
     1ARD RATE (M=',F7.4,') TIMES T (=',F7.4,')'/12X,'TO MAXIMUM AGE AT TRPOP134
     2RECRUITMENT (=',I2,')')                                           TRPOP135
  111 FORMAT(1H+,I4,106X,F10.0)                                         TRPOP136
  112 FORMAT(1H ,' ')                                                   TRPOP137
  113 FORMAT(1H1,5X,'RECRUITMENT BY AGES',//5X,'AGE',14X,'NUMBER',10X,'PTRPOP138
     1ROPORTION'/)                                                      TRPOP139
  114 FORMAT(5X,I3,10X,F10.0,10X,F10.4,1A1)                             TRPOP140
  115 FORMAT(1H0,/,1X,'* INDICATED AGES CONTRIBUTING LESS THAN 0.05 OF TTRPOP141
     1OTAL RECRUITMENT')                                                TRPOP142
  116 FORMAT(1H0,/,1X,'* INDICATES RECRUITMENT LESS THAN 0.95 COMPLETE')TRPOP143
      END                                                               TRPOP144
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      SUBROUTINE TGPOP
      DIMENSION POP(2,40),KITL(80),XMORT(10),TOTCH(40),TOTRC(40,2),F(40)TGPOP013
      DIMENSION HEFF(40),CHKWN(40),CHOUT(40),GCAT(40),CAT(40),RAGE(40)   TGPOP014
      DIMENSION           GPOP(40),RGTMP(84),IY(40),NDATA(12),PEW(15,40)TGPOP015
      DIMENSION ADDF(40),KKK(80),PTT(80,15),RGPP(80,84)
      DIMENSION RSEX(40),W(40),UUU(40,2,84)
      COMMON POP,KITL,I1,IFIN,MM,III,IGG,IXR,TOTCH,TOTRC,HEFF,XMORT,F,  TGPOP018
     1CHKWN,CHOUT,IFX,PEW,IG,RSEX,W                                     TGPOP019
      COMMON IOUT1,IOUT2,ISX,IF1,IF2,MXT,MX1,MX2,IAGA                   TGPOP020
      COMMON T,NDATA,MINA,MATF,ADDF,KKK,PTT,RGPP,UUU
  100 FORMAT (1H1,80A1/60(2H *))                                        TGPOP024
  101 FORMAT(1HO,'ESTIMATED POPULATION SIZE BY YEAR-CLASSES',/)         TGPOP025
  103 FORMAT(1H ,'YEAR-CLASS',45X,'YEAR OF CATCH',47X,'TOTAL')          TGPOP026
 1103 FORMAT(1HO,'AGE-GROUP ',45X,'YEAR OF CATCH')
  104 FORMAT(9X,15I7)                                                   TGPOP028
  105 FORMAT (60(2H -)/)                                                TGPOP029
  106 FORMAT(1H ,I4,2X,1HP,1X,15F7.0,/,7X,2HP ,15F7.0,/,7X,2HP ,10F7.0,/TGPOP030
     1)                                                                 TGPOP031
  107 FORMAT (1HO,'ANNUAL AGE COMPOSITION OF CATCHES')                  TGPOP032
  108 FORMAT(1H ,I4,4X,15F7.4)                                          TGPOP033
  109 FORMAT (9X,'IDENTIFICATION DATA ON CARDS  ',A1,1X,3A1,2X,5A1)     TGPOP034
  111 FORMAT(1H ,6X,2HC ,15F7.0,/,7X,2HC ,15F7.0,/,7X,2HC ,10F7.0)      TGPOP035
  113 FORMAT(1H+,113X,F7.0)                                             TGPOP036
      NLANK=16448                                                       TGPOP037
   22 DO 14 I=1,IF2
   14 IY(I)=I+IOUT1-1+1900
      IT=0                                                              TGPOP040
      JF2=2*IF2                                                         TGPOP041
      DO 205 L=1,JF2                                                    TGPOP042
      DO 350 I=1,84
  350 RGTMP(I) = RGPP(L,I)
      DO 206 J=1,84                                                     TGPOP044
      JJ=85-J                                                           TGPOP045
      IF(RGTMP(JJ))206,206,207                                          TGPOP046
  206 CONTINUE
      GO TO 205                                                         TGPOP048
  207 IF(IT-JJ)208,205,205
  208 IT=JJ
  205 CONTINUE
      GO TO (300,301),MM                                                TGPOP052
  300 WRITE(6,100)KITL
      WRITE(6,107)
      WRITE(6,109)  NDATA(1),(NDATA(I),I=3,5),(NDATA(I),I=8,12)
      WRITE(6,1103)
      WRITE(6,104)(IY(I),I=1,IF2)
      WRITE(6,105)
      DO 19 J=1,IT                                                      TGPOP059
      IAG=J-1                                                           TGPOP060
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```
      DO 119 I=1,IF2                                                    TGPOP061
      L=2*I-1                                                           TGPOP062
      RAGE(I) = RGPP(L,J)*RSEX(I)
      IK=L+1                                                            TGPOP065
  119 RAGE(I)=RAGE(I)+RGPP(IK,J)*(1.0-RSEX(I))
      IF(IF2-15)1119,1119,1120                                          TGPOP068
 1120 WRITE(6,108)IAG,(RAGE(K),K=1,15)
      WRITE(6,1080)(RAGE(K),K=16,IF2)
 1080 FORMAT(1H ,8X,15F7.4)                                             TGPOP071
      GO TO 19                                                          TGPOP072
 1119 WRITE(6,108)IAG,(RAGE(K),K=1,IF2)
   19 CONTINUE
      IF3=9+7*IF2                                                       TGPOP075
  301 WRITE(6,100)KITL
   12 WRITE(6,101)
      WRITE(6,103)
      WRITE(6,104)(IY(I),I=1,IF2)
      WRITE(6,105)
      IK=IT+IOUT2-IOUT1                                                 TGPOP082
      DO 26 IP=1,IK                                                     TGPOP083
      IRR=IOUT1-IT+IP+1900                                              TGPOP084
      DO 25 IM=1,IF2                                                    TGPOP085
      ITPMI=IT-IP+IM                                                    TGPOP086
      CAT(IM)=TOTCH(IM)+CHOUT(IM)                                       TGPOP087
      IF (IM-IP) 23,23,24                                               TGPOP088
   23 IF (IT-IP+IM) 24,24,251                                           TGPOP089
   24 GPOP(IM)=0.0
      GCAT(IM)=0.0                                                      TGPOP091
      GO TO 25                                                          TGPOP092
  251 IW=2*IM-1
      ROT = RGPP(IW,ITPMI)*RSEX(IM)
      IMM=IW+1                                                          TGPOP096
      ROT = ROT+RGPP(IMM,ITPMI)*(1.0-RSEX(IM))
      K10 = KKK(10)
      GPOP(IM)=POP(K10,IM)*ROT                                          TGPOP099
      GCAT(IM)= CAT(IM)*ROT                                             TGPOP100
   25 CONTINUE                                                          TGPOP101
      WRITE(6,106)IRR,(GPOP(IW),IW=1,IF2)
      TCAT=0.0                                                          TGPOP103
      DO 40 JX=1,IF2                                                    TGPOP104
   40 TCAT=TCAT+GCAT(JX)                                                TGPOP105
      WRITE(  6,113)TCAT
      WRITE(  6,111)(GCAT(JM),JM=1,IF2)
   26 CONTINUE                                                          TGPOP108
      MM=2                                                              TGPOP109
      RETURN
      END                                                               TGPOP111
```

```
      SUBROUTINE THEND
      DIMENSION ISWTH(15),ISTUS(2,3),RSEX(40),W(40)                     THEND009
      DIMENSION POP  (2,40),KITL(80),XMORT(10),TOTCH(40),TOTRC(40,2)    THEND010
      DIMENSION F(40),HEFF(40),CHKWN(40),CHOUT(40),PEW(15,40)           THEND011
      DIMENSION ADDF(40)
      DIMENSION NDATA(12),PTT(80,15),RGPP(80,84),KKK(80)
      DIMENSION NAME(6),UUU(40,2,84)
      COMMON POP,KITL,I1,IFIN,MM,III,IGG,IXR,TOTCH,TOTRC,HEFF,XMORT,F,  THEND014
     1CHKWN,CHOUT,IFX,PEW,IG,RSEX,W                                     THEND015
      COMMON IOUT1,IOUT2,ISX,IF1,IF2,MXT,MX1,MX2,IAGA                   THEND016
      COMMON T,NDATA,MINA,MATF,ADDF,KKK,PTT,RGPP,UUU
      DATA NAME/'O','N',' ','O','F','F'/
      ISTUS(1,1) = NAME(1)
      ISTUS(1,2) = NAME (2)
      ISTUS(1,3) = NAME(3)
      ISTUS(2,1) = NAME(4)
      ISTUS(2,2) = NAME(5)
      ISTUS(2,3) = NAME(6)
      WRITE(6,300)KITL
  300 FORMAT(1H1,20X,80A1)
      WRITE(6,301)
  301 FORMAT(1H0,'SWITCH NO.   STATUS   EFFECT IF ON')                  THEND033
      DO 20 I=1,15                                                      THEND038
      J = KKK(I)
      GO TO(101,102,103,104,105,106,107,108,109,110,111,112,113,114,115)THEND040
     1,I                                                                THEND041
  101 WRITE(  6,201)I,(ISTUS(J,JJ),JJ=1,3)
      GO TO 20                                                          THEND043
  102 WRITE(  6,202)I,(ISTUS(J,JJ),JJ=1,3)                              THEND044
      GO TO 20                                                          THEND045
  103 WRITE(  6,203)I,(ISTUS(J,JJ),JJ=1,3)
      GO TO 20                                                          THEND047
  104 WRITE(  6,204)I,(ISTUS(J,JJ),JJ=1,3)
      GO TO 20                                                          THEND049
  105 WRITE(  6,205)I,(ISTUS(J,JJ),JJ=1,3)
      GO TO 20                                                          THEND051
  106 WRITE(  6,206)I,(ISTUS(J,JJ),JJ=1,3)
      GO TO 20                                                          THEND053
  107 WRITE(  6,207)I,(ISTUS(J,JJ),JJ=1,3)
      GO TO 20                                                          THEND055
  108 WRITE(  6,208)I,(ISTUS(J,JJ),JJ=1,3)
      GO TO 20                                                          THEND057
  109 WRITE(  6,209)I,(ISTUS(J,JJ),JJ=1,3)
      GO TO 20                                                          THEND059
  110 WRITE(  6,210)I,(ISTUS(J,JJ),JJ=1,3)
      GO TO 20                                                          THEND061
  111 WRITE(  6,211)I,(ISTUS(J,JJ),JJ=1,3)
      GO TO 20                                                          THEND063
```

```
112 WRITE(   6,212)I,(ISTUS(J,JJ),JJ=1,3)
    GO TO 20                                                        THEND065
113 WRITE(   6,213)I,(ISTUS(J,JJ),JJ=1,3)
    GO TO 20                                                        THEND067
114 WRITE(   6,214)I,(ISTUS(J,JJ),JJ=1,3)
    GO TO 20                                                        THEND069
115 WRITE(   6,215)I,(ISTUS(J,JJ),JJ=1,3)
    GO TO 20                                                        THEND071
 20 CONTINUE                                                        THEND072
201 FORMAT(1H ,I5,10X,3A1,2X,'CALLS EXIT - OFF RETURNS TO WHPOP')     THEND073
202 FORMAT(1H ,I5,10X,3A1,2X,'USED FOR TRACE IN TXTRP')              THEND074
203 FORMAT(1H ,I5,10X,3A1,2X,'NOT USED')                            THEND075
204 FORMAT(1H ,I5,10X,3A1,2X,'NOT USED')                            THEND076
205 FORMAT(1H ,I5,10X,3A1,2X,'NOT USED')                            THEND077
206 FORMAT(1H ,I5,10X,3A1,2X,'NOT USED')                            THEND078
207 FORMAT(1H ,I5,10X,3A1,2X,'NOT USED')                            THEND079
208 FORMAT(1H ,I5,10X,3A1,2X,'NUMBER OF RECRUITS BY YEAR CLASS ESTIMATTHEND080
   1ED')                                                            THEND081
209 FORMAT(1H ,I5,10X,3A1,2X,'PERMITS CONSOL ENTRY OF Q VALUES')     THEND082
210 FORMAT(1H ,I5,10X,3A1,2X,'EQUAL CATCH METHOD USED TO ESTIMATE POPUTHEND083
   1LATION AND RECRUITS')                                           THEND084
211 FORMAT(1H ,I5,10X,3A1,2X,'AGE DISTRIBUTION OF POPULATION WANTED') THEND085
212 FORMAT(1H ,I5,10X,3A1,2X,'NOT USED')                            THEND086
213 FORMAT(1H ,I5,10X,3A1,2X,'INTERMEDIATE SUMS OF SQUARES PRINTED')  THEND087
214 FORMAT(1H ,I5,10X,3A1,2X,'POP(I) AND SUM OF SQUARES FOR GIVEN Q') THEND088
215 FORMAT(1H ,I5,10X,3A1,2X,'USED WITH TRACES ONLY')               THEND089
499 RETURN
    END                                                             THEND094
```

```
PROGRAM  FALSE TARGET
      DIMENSION SPM(5),SPF(5),FM(5),FF(5),SM(5),SF(5),A(12),B(12),C(12),
     1D(12),E(12),F(12),AW(12),MW(12),MONTH(12),PM(12)
      REAL*8 TITLE,SQUARE,N9/'    9'/,N99/'99999'/
C
C  CALCULATE TOTAL POPULATION IN AREA
C  Z IS TOTAL CATCH IN AREA
C  R=SONAR RANGE IN KILOYARDS
C
 1000 READ(5,100) TITLE
      READ(5,200) Z
      READ(5,250)MONTH
      R=1000
      DIST=1000
      READ(5,300)SPM,SPF,FM,FF,SM,SF
      TSP=0
      DO 10 I=1,5
   10 TSP=TSP+SPM(I)+SPF(I)
      TF=0
      DO 20 I=1,5
   20 TF=TF+FM(I)+FF(I)
      TS=0
      DO 30 I=1,5
   30 TS=TS+SM(I)+SF(I)
      N=0
      N=N+(TSP/10)+(TF/10)+(TS/10)
      WRITE(6,350)
      WRITE(6,400)TITLE,Z
      WRITE(6,450)
      DO 40 I=1,5
   40 WRITE(6,500)SPM(I),SPF(I),FM(I),FF(I),SM(I),SF(I)
      WRITE(6,550)N
C
C  NOW CALCULATE INDIVIDUAL SQUARES
C  Y EQUALS NUMBER IN SQUARE BY CATCH
C  DIST=DISTANCE STEAMED=1000 NM
C  AR=AREA OF SQUARE
C  AW IS THE AVERAGE NUMBER OF WHALES IN THE SQUARE BY MONTH FOR FIVE YRS
C  TAW SI TOTAL WHALES IN SQUARE
C  PM=NUMBER OF WHALES ENCOUNTERED IN STEAMING 1000 NM
C
 2000 READ(5,600)SQUARE
      IF(SQUARE.EQ.N9) GO TO 1000
      IF(SQUARE.EQ.N99) GO TO 3000
      READ(5,650)Y
      READ(5,700)AR
      READ(5,750)A,B,C,D,E
      DO 50 I=1,12
```

```
   50 F(I)=A(I)+B(I)+C(I)+D(I)+E(I)
      DO 60 I=1,12
   60 AW(I)=F(I)/5
      TAW=0
      DO 70 I=1,12
   70 TAW=TAW+AW(I)
      PW=(Y/Z)*N
      DO 80 I=1,12
   80 MW(I)=(AW(I)/Y)*PW
      DO 95 I=1,12
   95 PM(I)=(MW(I)/AR)*DIST*(R/2000)
      WRITE(6,800)
      WRITE(6,850)SQUARE,Y
      WRITE(6,900)
      DO 90 I=1,12
   90 WRITE(6,950)MONTH(I),AW(I),MW(I),PM(I)
      WRITE(6,975)
  100 FORMAT(A8)
  200 FORMAT(F6.0)
  250 FORMAT(12A4)
  300 FORMAT(10F6.0)
  350 FORMAT(' ')
  400 FORMAT(1X,A8,6X,F6.0)
  450 FORMAT('0',16X,'SPERM',17X,'FIN',20X,'SEI',/,3(8X,'MALE',6X,
     1'FEMALE'))
  500 FORMAT('0',6(6X,F6.0))
  550 FORMAT('0',I6)
  600 FORMAT(A5)
  650 FORMAT(F6.0)
  700 FORMAT(F6.0)
  750 FORMAT(12F6.0)
  800 FORMAT(' ')
  850 FORMAT(' ',1X,A5,6X,F6.0)
  900 FORMAT('0',18X,'AVE/MO',8X,'POP/MO',8X,'WHALES')
  950 FORMAT(7X,A4,8X,F6.0,8X,I6,8X,F6.2)
  975 FORMAT('0','******************************************************
     C**************************************')
      GO TO 2000
 3000 STOP
      END
```

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13. ABSTRACT

False Sonar targets present a serious unpredicted problem to U.S. Navy ASW units. It is believed that planning and operations could be enhanced by a forecasting capability for whale distribution. As a possible solution to this problem, a modified form of the "Transect Method of population estimation" is applied to whaling data to calculate probable numbers of false targets per 1000 nautical miles of steaming with a 1000 yard sonar range. Japanese and Russian whale fishery data are analyzed by the "q" and Expected Catch methods of population dynamics to obtain two independent estimates of the populations of fin, sei and sperm whales. The mean of the two estimates is applied to the equation along with a term for assumed ideal sonar conditions. The data is calculated by ten degree square of latitude and longitude, north of 30°N, and presented on Fleet Numerical Weather Central polar stereographic charts for the months April through December. The number of false targets attributable to fin, sei and sperm whales alone range from 1 to 63 south of the Aleutian Islands and 1 to 30 off Honshu, Japan.

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